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Catop-tricks 8

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ARITHMETICK

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A

MATHEMATICAL
MISCELLANY
IN FOUR
PARTS;

I. An ESSAY towards the PROBABLE Solution of the Forty-five *Surprising* PARADOXES, in *GORDON*'s *Geography.*

II. Fifty-five *N E W* and *Amazing* PARADOXES, some in Verse, some in Prose, with their Solutions.

III. A N S W E R s, to the Hundred ARITHMETICAL PROBLEMS, left unanswer'd in *HILL*'s ARITHMETICK, and *ALEXANDER*'s ALGEBRA.

IV. Miscellaneous Rules about forming *Ænigma*'s, *Questions,* the Doctrine of *Eclipses,* of *Pendulums,* the *Equation* of *T I M E,* concerning *Easter,* &c.

By a Lover of the MATHEMATICKS.

The *Second Edition* Corrected.

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PART I.
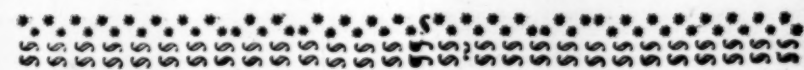
GORDON's PARADOXES SOLV'D

A PARADOX is a *seeming* Falſity, but a *real* Truth; 'tis that which to *unthinking* Perſons, ſeems abſur'd or impoſſible; but to a *thoughtful* Man, is plain and evident: The main Drift whereof is to *whet* the Appetite of an *inquiſitive* Learner, and to ſet him upon *Thinking*.
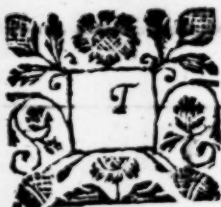
1. *THERE*

I. **T**HERE are two remarkable Places on the Globe of the Earth, in which there is only one Day and one Night throughout the whole Year.

Anſwer, The two remarkable Places are the two Poles; for to the *North Pole*, the *Sun* riſes about the 10th of *March*, and ſets not till about the 12th of *September*: and the enſuing Twilight continues till the *Sun* be eighteen Degrees below the *Horizon*, i. e. about the ſecond of *November*, then dark Night continues till about the 18th of *January* at which Time the Day breaks. and the Morning Twilight continues 'till *Sun* riſe on the 10th of *March*. Hence betwixt *Sun* riſe and *Sun* ſet are ſix Months, but betwixt Day-break and Twilight's End are about two Hundred and eighty eight Days, but Totally dark only ſeventy ſeven Days.

N O T E, When it riſes to the *North Pole*, it ſets to the *South, & e contra*; and becauſe it riſes but once, and ſets but once in the Year, to either, there is but one Day and one Night in the whole Year.

2. *There are alſo ſome Places on the Earth in which 'tis neither Day nor Night, at a certain Time of the Year, for the Space of twenty four Hours.*

Anſwer, If by *neither Day nor Night*, be meant Twilight, it may be any Climate of the *Frigid Zones*; but if it be underſtood that the *Sun* neither riſes nor ſets for 24 Hours, the Places muſt be ninety Degrees diſtant

d:ftant from the *Sun*: Thus, if the *Sun* be in the *Æquator*, then the *Poles* are the Places; for at thofe Times the *Sun* circuits about their *Horizon* for twenty - four Hours, half above and half under it ; hence for fo long, 'tis neither Day nor Night then and there.

3. *There is a certain Place of the Earth, at which, if two Men fhould chance to meet, one wonld ftand upright upon the Soles of the other's Feet, and neither of them fhould feel the other's Weight, and yet they both fhould retain their natural Pofture.*

Anfwer, He fays *of the Earth*, not *on the Earth*, which therefore means the Center thereof ; for imagine an Hole bor'd thro', from our Feet, to and thro' the Center of the Earth, to the oppofite Point, or the *Antipodes*, and one Man defcended towards the Center at one End of the Hole, and another Man defcended at the other End of the Hole, till they both met at the Center, fo would they ftand on each other's Feet, with their Heads towards the *Zenith*, in their natural Pofture without feeling each other's Weight According to thefe Maxims, *No heavy Body gravitates in the Center*, and *All heavy Bodies tend to the Center;* whereas a *Gravitation* at the very Center, muft imply neceffarily a *Divergency* from the Center, or an Afcent which is abfur'd:

4. *There is a certain Place of the Earth where a Fire being made, neither Flame nor Smoke would afcend, but move circularly about the Fire : Moreover, if in that Place one fhould fix a fmooth or plain Table, without any*

Ledges

Ledges whatfoever, and pour thereon a large Quantity of Water, not one Drop thereof would run over the faid Table, but would raife itfelf up in an Heap.

Anfwer. This Place muft alfo be the Center of the Earth, for the Reafons mention'd in the laft.

5. *There is a certain Place on the* Globe, *of a confiderable Sonthern Latitude, that hath both the greateft and leaft Degree of Longitude.*

Anfwer; This may either mean the *South Poles*, which hath not only the leaft but greateft, and all intermediate Degrees of Longitude, all which meet in the *Poles.* Or all Places that lye under the firft *Meridian*, have both the leaft and greateft Degree of Longitude, as at Noon is the greateft and leaft Number of Hours; becaufe then and there we begin and end our Reckoning.

Thus *Trinidada,* is in Latitude *South*, 20 Degrees, and under the firft *Meridian*, with them who reckon from St. *Michaels*'s, or *Triftam de Cunba*, is in thirty fix Degrees fifty four Minutes *South* Latitude, and the fame Longitude, with *Teneriff*; all which, according to the old Way of reckoning Longitude, are not only in the Beginning of the firft Degree, but alfo in the End of the three Hundred and fixtieth Degree of Longitude.

6. *There are three remarkable Places on the* Globe *that differ both in Longitude and Latitude, and yet all lye under one and the fame* Meridian.

Anfwer; By the *Globe*, may be meant the *Artificial Globe*, and by the *Meridian* may be meant the *Brazen Meridian,*

Meridian, belonging to it, which may be five Degrees thick; then fuppofe three Places, *A, B, C. A* to be *Dublin,* in Latitude fifty three Degrees and an half, and Longitude twenty Degrees; *B* to be *Lisbon,* in Latitude thirty eight Degrees and an half, Longitude eighteen Degrees; *C* to be the Ifle of *Paxaros,* in Latitude eight Degrees, and Longitude two Hundred Degrees, all which, tho' they differ both in Longitude and Latitude, yet may they all lye under one and the fame *Brazen Meridian,*

Or without Equivocation, fuppofe one Place under the *Pole,* a fecond on this Side, and a third on the other under the fame *Meridian* Circle, fo may they all differ both in Longitude and Latitude; for the *Pole* contains all Degrees of Longitude.

7. *There are three remarkable Places on the* Continent of Europe *that lye under three different* Meridians, *and yet all agree both in Longitude and Latitude.*

Anfwer. Divers *Geographers* begin their firft *Meridian* at divers Places; thus *Ptolomy* at *Cape Verde* (formerly one of the *Fortunate Iflands*) *Mercator* at St. *Michael's* in the *Azores*; *Bleau* at *Teneriff,* one of the *Canary Ifles, &c.* Now if you take (under the fame Latitude) three Places (fuppofe ten Degrees from each of thefe firft *Meridians*) they agree all in Latitude, alfo in Longitude, from thefe three refpective Places and yet lye under three different *Meridians,* in refpect of the *Globe,* or which is much to the fame Purpofe, chufe any three Places under different *Meridians,* and one Parallel of Latitude, as *Pico,* St. *Nicholas,* and *Lisbon,* and begin the Longitude at every one of them; fo will they all be firft *Meridians,* and agree in having no Longitude, and being in the fame Parallel will agree alfo in Latitude.

8. *There*

8. *There is a certain Ifland in the Ægean Sea, upon which if two Children were brought forth at the fame Inftant of Time, and living together for feveral Years, fhould both expire on the fame Day, yea at the fame Hour and Minute of the Day, yet the Life of one would furpafs the Life of the other by divers Months.*

Anfwer, Different Parts of the faid Ifland may be fuppofed to compute differently, fome by the *Solar* Year, fome by the *Lunar*; or fome ufe different Courfes of the *Moon*; in one Place her *Periodical,* and in other Places her *Synodical,* which is a larger Revolution than the former; fo within the Compafs of fome Years the Difference will amount to feveral Months : Or fuppofe the Ifland to be *Negropont,* in the *Ægean* Sea, where both *Chriftians* and *Turks* dwell; now the *Turks* follow the *Lunar* Year, which is 11 Days lefs than the *Solar,* which the *Chriftians* account by. Now if the Children fhould live thirty *Solar* Years together, and then die, the *Turks* would account them about 10 Months older than the *Chriftians.* Or if one of the Children fails directly *Eaft,* and the other directly *Weft,* when they encompafs the *Globe* of the Earth, once (which is now eafily done in a Year) there will be two Days Difference in their Age, and in forty Years thus Sailing, the one would be eighty Days older than the other. Or fuppofe the one lives without the *Artic Circle,* where no Day exceeds twenty-four Hours, and the other goes and lives in the Latitude of feventy three Degrees twenty Minutes, where the Day is 3 Months long, and then returns, and both die at one Inftant, the one will be three Months older than the other; but the two firft Solutions feem preferable, becaufe of thefe Words in the Paradox, *living together for feveral Years*; yet becaufe the two laft carry Inftruction

tion along with them, I would not omit the Mention of them.

9. *There are two obfervable Places belonging to* A S I A *that lye under the fame* Meridian, *and of a fmall Diftance from one another; and yet the refpective Inhabitants of them, in reckoning their Time, do differ an intire natural Day every Week.*

Anfwer. This alfo may be folved two Ways, firft if they keep their Sabbaths on different Days of the Week, as the *Chriftians* on *Sunday,* the *Græcians* on *Monday,* the *Perfians* on *Tuefday,* the *Affyrians* on *Wednefday,* the *Ægyptians* on *Thurfday,* the *Turks* on *Friday,* the *Jews* on *Saturday.* Or better thus, the two Places, are, one *Macao,* and the other the *Fhilippine Ifles,* near each other and under the fame *Meridian,* yet they differ one Day in their Account; for, in the *Philippine Ifles* the *Spaniards.* when it is their laft *Saturday* in *Lent.* the *Portuguefe* in *Macao,* eat Flefh, it being their firft *Sunday* in *Eafter*: The Caufe of this Difference is the *Spaniards* failed thither *Wefterly,* and loft half a Day, and the *Portuguefe* failed thither *Eafterly* and gained half a Day.

10. *There is a particular Place of the Earth where the Winds (tho' frequently veering round the* Compafs *) do always blow from the* North *Point.*

Anfwer. Under the *South Pole* directly; for all Winds blowing there muft needs blow *North,* as all Winds blowing at the *North Pole* muft needs blow *South,* becaufe there the *Meridians,* which are *North* and *South,* are the *Azimuths* all concentring in the *Pole,* which is their *Zenith.*

DI. *There*

11. *There is a certain Hill, in the* South *of* BOHEMIA, *on whose Top, if an Equinoctial Sun-Dyal be duly erected, a Man that is Stone blind may know the Hour of the Day by the same, if the* Sun *shines.*

Answer, Perhaps it never doth shine on that Hill because there is a Mountain that is said to encircle all *B O H E M I A,* or never till Noon ; so then, if you tell the blind Man the *Sun* shines, he'll tell you 'tis Twelve o'Clock : Howbeit, I know not a better Way to make a blind-Man's Sun-Dyal than this.

Fill a Glass Globe with Water: which fix in a Sphere, with Twelve polished Iron Meridians each having so many Nicks as the Number of Hours belonging thereto; which let be fixed, precisely at the Distance of the *Focus,* from the *Globe;* so will the *Globe* full of Water unite the Solar Rays that they'll burn at a Distance ; thus this Equinoctial Dyal being fix'd in the Sun-shine, on a Hill or Valley, one that is Stone blind may feel which *Meridian* is hottest, and grope out, by the Nicks, the Number of the present Hour.

12. *There is a considerable Number of Places, lying within the* Torrid-Zone, *in any of which, if a certain kind of* Sun-Dyal *be duly erected, the Shadow will go back several Degrees upon the same at a certain Time of the Year, and that twice every Day, for the Space of divers Weeks ; yet no ways derogating from that miraculous returning of the Shadow upon the Dyal of* Ahaz, *in the Days of King* Hezekiah.

Answer,

Anfwer, Any where in the *Torrid Zone,* where the Latitude is lefs than the Declination of the *Sun,* and both towards the fame *Pole :* The *Sun* comes twice to the fame Point of the *Compafs* both Forenoon and Afternoon ; and an Equinoctial Dyal, placed Horizontally, the Shadow of the Gnomon fhall go back, *plus minus,* twice every Day. But becaufe the Paradox mentions *a certain kind of Dyal* I fuppofe it may be thus anfwered, by a plain Equinoctial Dyal, defcrib'd on both Sides of a Horizontal Plain, and with two Gnomons, and near the *Tropic,* when the Latitude and Declination are equal; before the *Sun* comes to the Mathematical *Horizon* in the Morning, he will fhine on the lower Side of the Plane, and the Shadow of the Gnomon will run *Weftward ad infinitum,* and prefently after fix o'Clock, as he fhines on the upper Plain, the Shadow runs *Eaftward* till Noon, and thence to fix in the Evening, at which Time the Shadow, on the lower Plane, will begin, and run *Weftward* till Sun fet; there may, by Concave, Convex, and Reflex Dyals, be other Ways of folving this.

Note, in the Latitude Eighteen Degrees *North,* the Retrogradation of the Shade will continue, more, or lefs, from the firft of *May,* to the 20th of *July, i. e.* Eighty Days, which the *Sun* fpends in moving from Eighteen Degrees. *North* Declination, till it come back to the fame Degree again.

13. *There are divers Places on the* Continent *of* A F R I C A, *and the Iflands of* Sumatra *and* Borneo, *where a certain kind of Sun-Dyal being duly fix'd; the Gnomon thereof will caft no Shadow at all during feveral Seafons of the Year : and yet the exact Time of the Day may be known thereby.*

Anfwer,

Anfwer, An Horizontal Dyal, under the Equi-noctial Line, cafts no Shadow at Twelve o'Clock, Twice every Year; or becaufe the Places mention'd in the Paradox are betwixt the *Tropics*, the *Sun* comes Twice in the Year to their *Zenith*, and then the Gno-mon cafts no Shadow exactly at Noon; or it may be the blind Man's Dyal aforefaid in the Eleventh Paradox: But I rather take it to be a *Globe*, recti-fied according to the Latitude and Day of the Month, and the Index to the Hour Twelve, and to the *Sun's* Place apply a Perpendicular or Spheric Gnomon, which is to be there fix'd, and the Globe turn'd till it caft no Shadow, fo will the Globe's Index point out the Hour any Time when the *Sun* fhines as well in thefe Parts of the *World* as in thofe Iflands; for Dyals may be madeto fhew the Hour, without Shade of either Stile or Hour-Line, as a Globical Dyal. ha-ving a moveable Equator, and a fixed Stile or Gno-mon thereon.

14. *There is a certain Ifland in the vaft* Atlantic Ocean, *which being defcry'd by a* Ship at Sea, *and bearing due* Eaft *off the faid* Ship, *at twelve Leagues Diftance by Eftima-*tion; *the trueft Courfe for hitting the faid* Ifland, *is to fteer fix Leagues due* Eaft, *and juft as many due* Weft.

Anfwer, The Prime *Meridian*, from whence Longi-tude is accounted, both Ways, Eaft and *Weft*, paffes thro' the Middle, betwixt the Ship and Ifland, and fo Regard is had to the *Eaft* and *Weft* Longitude, and not to the Points of the *Compafs*.

15. *There*

15. *There is a remarkable Place in the
Globe of the Earth, of a very pure and whol-
fom Air to breath in; yet of fuch a ftrange
and deteftable Quality, that it is abfolutely im-
poffible for two of the intlreft Friends that
ever breathed, to continue in the fame in mu-
tual Love and Friendfbip for the Space of two
Minutes of Time.*

Anfwer, 'Tis impoffible for two Perfons to be in
one and the felf fame individual Place together: O-
thers fay, by Reafon of the Earth's Motion they can-
not continue in the fame Air; others fay, two in
the Throne cannot continue in mutual Love and
Friendfhip; or there may be Vulcano's. Caves and
Lakes, which emit Sulphureous, peftilential and killing
Vapours, tho' fituate in a pure wholfom Air; as
S I C I L Y, J U D Æ A, and *I C E L A N D,* in
which are an Æne, or Dead Sea. and in the laft
both; but I rather take it to be directly under the
Poles, which, by Reafon of its fuperlative Cold, muft
needs have a pure Air; but we hear of none that e-
ver got within an hundred Leagues of them, let a-
one to ftay two Minutes there, by Reafon of the
Mountains of Ice, frozen Sea, and Excefs of Cold for
a thoufand Miles round them.

16. *There is a certain noted Place, in the
vaft Atlantic Ocean, where a brisk Levant
is abfolutely the beft Wind for a Ship that
is to fhape a due Eaft Courfe, and yet fhe fhall
ftill go before it.*

Anfwer, If the Place be *Eaftward* of the *Levant* a
Ship may be carried by an *Eaft* Wind round the
Globe

Globe to it, provided fome *Eaft* Point be fixed ; or
where there is a violent Tide ; as the Gulf of
Florida may be meant : But the Quibble may lie in the
Word *fhape* ; for an *Eaft* Wind may be beft for car-
rying her out of an Harbour, to fail to a Place on
the *Eaftern* Part of that Ifland or Continent ; or it
may mean the Streights of *Gibraltar*, ; for a brisk
Levant raifes the *Mediterranean*, in fo much that the
Paffage thro' them is the fafer, as 'tis to come into
an Harbour, when High Water : Thus, if I miftake
not, in the *Eaft India* Voyages, near or on the Line,
a Wind from the Levant feems to be the only
Wind to keep a Ship from being driven to the *African*
Shore.

17. *There are divers remarkable Places, up-
on the* Terraqueous Globe, *whofe fenfible*
Horizon *is commonly fair and ferene ; and
yet 'tis impoffible to diftinguifh properly in it
any one of the intermediate Points of the* Com-
pafs, *nay, or fo much as two of the four* Car-
dinal *themfelves.*

Anfwer, Under either of the *Poles*, in which all
the Points of the *Compafs* meet in a Center, as afore-
faid, in Paradox, 5, 10, foregoing.

18. *There is a certain Ifland in the* Bal-
tic Sea, *to whofe Inhabitants the Body of
the* Sun *is clearly vifible, in the Morning before
he Rifeth, and likewife in the Evening after
he is Set.*

Anfwer, This is occafioned by Refraction, fome
of whofe Properties are, 1. That oblique Rays
out of a thinner Medium, falling on a groffer and

fracted. or accede towards the Perpendicular let fall from their Entrance.

But 2dly, Rays out of a groffer Medium into a thinner, recede further from the faid Perpendicular.

3dly, Perpendicular Rays are not refracted.

4thly, The greater is the Refraction, the further the Rays are from being perpendicular.

Hence 'tis that the Sun and Stars Refraction, is greater, the nearer they be to the *Horizon*, alfo the thicker the Atmofphere, the greater the Refraction; as near the *Poles* and in the *Northern* Seas, as the *Baltic.*

Refraction is ufeful in the firft Difcovery of Land upon Sea, raifing the Tops of Mountains in the Air, to be feen feveral Leagues further off, than they would be were there no Refraction.

This made the *Hollanders* in *Nova Zembla*, fee the Sun rife fome fixteen Days before they expected it, or would have feen it had there been no Refraction.

This alfo is the Reafon why a Piece of Silver, which could not be feen in a Bafon, yet being covered with Water. a thicker Medium than Air appears vifible: And alfo, why, if a Man would fhoot a Salmon under Water, he muft not aim at that Point of the Water where the Ray of Sight enters, but a great Way on this Side of it; as if the Salmon was in the Perpendicular let fall from the Point where the Ray of Sight enters the Water.

The ingenious *Lowthorp*, about 1700. gave ocular Demonftration of the Refraction, by making a Vacuum between two inclin'd Planes of Glafs, by the help of Quick-filver, thro' which an Object, view'd with a Telefcope was feen, upon Re-admiffion of the Air very fenfible to change Place according to the different Denfity thereof, See *P. Tranf.* N° 257.

19. *There is a certain Village, in the King-dom of* NAPLES, *fituated in a very low*

low *Valley* ; and yet the Sun *is nearer to the Inhabitants thereof, every Noon by three Thousand Miles and upwards, than when he either Riseth or Setteth to those of the said Village.*

Answer, The Sun is nearer Noon to the Inhabitants of any Part of the Earth, as well as *Naples*, by the Semi-diameter of the Earth; which, by the most accurate Observations yet made, is three Thousand six Hundred and ninety two *English* Miles.

20. *There is a certain Village, in the* South *of* Great-Britain, *to whose Inhabitants the Body of the Sun is less visible, about the Winter Solstice, than to those who reside upon the Island of* Iceland.

Answer, This Village, perhaps, is near *Lewis* in *Sussex,* lying under an high Mountain; there, about the Time of the *Winter* Solstice, the Sun is but a small Time visible to the Inhabitants, or some Valley or Glin surrounded with Hills, in or near *Wales*, that in the *Winter* 'tis near Noon e're the Sun approach them, and then disappears presently ; whereas in an open Place in *Iceland,* or on the Top of an high Mountain, there the Sun may much sooner and much longer appear, and the more because of the Greatness of Refraction, which the grossness of the Atmosphere magnifies : Moreover, in Glins, near Mountains, 'tis observable, there is least Sun-shine, because Mists are more frequent.

21. *There is a vast Country in* ÆTHIOPIA SUPERIOR, *to whose Inhabitants the Body of the* Moon *doth always appear to be*

*moſt enlightned when ſhe is leaſt enlightned, and
to be leaſt, when moſt.*

Anſwer, " The Light that falls upon any Body,
" being always in a reciprocal duplicate Ratio of
" the Diſtance from the Luminous Bodies " Hence
it follows, that not only in *ÆTHIOPIA,*
but in all Parts of the World, the Moon doth always
appear to be moſt enlightned at the Full, when
ſhe is leaſt enlightned, becauſe ſhe is then remo-
ved from the Sun farther than at the New Moon;
by the Diameter of the Moon's Orbit, at which
Time, tho' neareſt to the Sun, ſhe appears leaſt en-
lightned to us, when ſhe is, in Reality. moſt; Or
ÆTHIOPIA, Inferior or *Superior,* being ſitua-
ted near and under the *Tropic* of *Capricorn,* and hath
Valleys ſurrounded with prodigious high Mountains,
and the Terms, *moſt and leaſt enlightned* may either
reſpect the Moon's Body, or the Time of her ſhi-
ning.

1. *If her Body,* obſerve that, the Moon is as well
enlightned by the Earth as the Earth by the Moon,
is diſcovered by Teleſcopes in the Hands of modern
Philoſophers; and neither the Antients did, nor
Moderns do Queſtion, that both receive Light from
the Sun : Wherefore, at the Full, when ſhe ſeems
moſt enlightned to any one Place, ſhe is leaſt, in
reſpect of her ſelf, becauſe then, ſhe receives only
hoſe Rays that come directly from the Sun : But
at the New Moon, when ſhe ſeems leaſt enlightned
to us, ſhe is moſt in reſpect of her ſelf, becauſe ſhe
receives Light from the Sun, on that Side next him,
and Light from his Beams reflected from the Earth,
to that Part of the Moon next us ; ſo at Con-
junction, ſhe is, in a manner, wholly illuminated in
her ſelf and but half in Oppoſition.

2. *If it reſpect the Time of her Shining,* ſeeing 'tis
Winter in *ÆTHIOPIA,* when Summer with
us, *&c e contra,* they have longeſt Nights when
ours

B 3

ours ate fhorteſt, and the contrary ; wherefore to them the Moon will be moſt enligntned, or fhine longeſt, when to us leaſt, and alſo moſt to us, when leaſt to them.

22. *There is a certain Iſland (whereof Mention is made by ſome of our lateſt Geogra phers) whoſe Inhabitants cannot properly be reckoned either Male or Female, nor altogether Hermaphrodites ; yet ſuch is their peculiar Quality, that they are ſeldom liable unto either Hunger or Thirſt, Cold or Heat, Joy or Sorrow, Hopes or Fears, or any ſuch of the common Attendants of Life.*

Anſwer, If Puppets, Inſects, Stones, Animalcules, Birds, Fiſhes or Plants, by a Catachreſis may be call'd Inhabitants, then may our Author mean the Iſland of Parrots, ſituated in *Terra Auſtralis Incognita,* or any uninhabited Iſland, diſcovered by our lateſt Travellers, where no other Inhabitants are, ſave ſuch Plants, Fiſh, Stones, Inſects and Animalcules.

23. *There is a remarkable Place of the Earth, of a conſiderable Southern Latitude, from whoſe Meridian the Sun removeth not for ſeveral Days, at a certain Time of the Year.*

Anſwer, 1. 'Tis doubtleſs under the *South Pole;* but, 2. Taking Sun for Sun-ſhine by a Metonymy, it may intend any Place beyond the *Antartic Circle* ; and then it will not mean that the Sun ſtands ſtill in the *Meridian,* but that he enlightens

it for as many Days as he is above their Ho and this is ufual, when we fay the Sun moves not from fuch a Wall or Dyal for fo many Hours : Thus in Latitude fixty eight Degrees *South*, the Sun fhines upon its *Meridian* conftantly for thirty Days.

24. *There is a certain Place of the Earth, of a confiderable* Northern Latitude *, where tho' the Days and Nights (even when fhorteft) do confift of feveral Hours ; yet in that Place it's Mid-day, or Noon every Quarter of an Hour.*

Anfwer, Under the *North* Pole. for there every *Azimuth* is a *Meridian*, and the Sun's Courfe is nearly parallel to the Horizon all the Year.

25. *There are divers Places on the* Globe *of the* Earth, *where the* Sun *and* Moon, *yea and all the* Planets, *do actually Rife and Set according to their various Motions, but never any of the fix'd Stars.*

Anfwer, Under the *Poles*. the Planets by their Motions. get *North* and *South* Declination, confequently Rife and Set, with relation to thofe two Places ; but the fixed Stars keeping an exact Diftance from the *Pole*, may be faid never to Rife or Set, tho' their Motion, on the *Poles* of the *Ecliptic*, may be thought fome fmall Objection to this Paradox : Or if by *divers Places*, he meant many, or more than two he may intend any Place in ENGLAND, DENMARK, or GERMANY, where Spheres are, or Pieces of Artificial Clock-work, &c. fhewing the Rifing and Setting of the Planets, but none of the fix'd Stars.

26. *There*

26. *There is a very remarkable Place, upon the* Terraqueous Globe, *where all the Planets, notwithstanding their different Motions and various Aspects, do always bear upon one and the same* Point *of the* Compass.

Answer, Under either of the *Poles,* for Reasons in Paradox 5. 10. 17. 23. 24, 25; for to an Eye situate in the *North* or *South Pole,* all the Stars, however situate. will bear on the *South* or *North* Point of the *Compass.* because every *Azimuth* becomes a *Meridian,* the *Zenith* and *Pole* being but one and the same Point.

27. *There is a certain noted Part of the Earth, where the* Sun *and* Moon (*ipso tempore plenilunii*) *may both happen to Rise at the same Instant of Time and upon the same* Point *of the* Compass.

Answer, Under the *Poles* for Reasons in the last. to which add Refraction which raises the Object into and above the *Horizon,* when 'tis considerably under the same. *See Paradox* 18.

28. *There is a certain Place, on the Continent of* EUROPE, *where, if several of the ablest Astronomers (the World now affords) should nicely observe the celestial Bodies, and that at the same Instant of Time, yet the planetary Phases and their various Aspects, would be really different to each of them.*

Answer, Some say, that neither at the Center, or

any Part of the Earth, no one can obferve all the Celeftial Bodies at one and the fame Inftant of Time.

2. Others anfwer thus, if one of thefe able Aftronomers fhall nicely obferve the Heliocentric Place of the Planets, another the Geocentric; their Phafes and Afpects would be realty different to each of them.

Or, 3. This Paradox may refpect the various Syftems of the ableft Aftronomers, whether *Ptolomy*, *Pythagoras* or *Tycho*. to each of whom the Planets would have both different Phafes and Afpects, were they nicely obferved in any Part of the World; becaufe *Ptolomy* fix'd the Earth in the Center, the Sun betwixt *Venus* and *Mars*; but *Pythagoras* and *Copernicus* placed the Sun in the Center of all, and the Earth betwixt *Venus* and *Mars*, and *Tycho* blending both Syftems aforefaid, borrows from each, but agrees with neither; he fuppofing the Earth in the Center of Sun, Moon and fix'd Stars, daily to revolve on its Axis. and the Sun in the Center of the other five Planets, revolving about the Earth in one Year.

Or, 4. By the Word *Afpects* in this Paradox. refpect may be had to the ableft Aftrologers quartering, and trifecting or various Ways of erecting their Schemes of the Heavens.

Suppofe.

					th			th	
A		Regiomontanus,			Saturn	11		Venus	9
B	following	Campanus,	may put		Saturn	12	and	Venus	9	Houfe.
C		Alcabitius,			Saturn	10		Venus	8
D		Ptolomy,			Saturn	10		Venus	8

Thus, may B, have a fquare mundane Afpect of *Saturn* and *Venus*, when A. C. D. have a Sextile, & *fic de cæteris*. And this may be in any Place, where fuch Aftrologers of different Judgments meet, whether they be Difciples of *Regiomontanus*, *Ptolomy*, &c.

Laftly,

Laftly. If *Celeftial Bodies* mean, by a Metonymia *figni ure fignata,* the Planets. in certain Spheres in GER-MANY, viewed by feveral able Aftronomers, at the fame Inftant of Time, their planetary Phafes and Afpects would be really different to each of them, by Reafon of their Parallax of Sight and Situation, one feeing fome Point of the fame Planet hid from the Sight of the other, and on a different Point of the *Compafs.*

29. *There is a large and famous Country, on the* Continent of AFRICA, *many of whofe Inhabitants are born perfectly deaf, and others Stone-blind, and continue fo during their whole Lives, and yet fuch is the amazing Faculty of thofe Perfons, that the Deaf are as capable to judge of Sounds as thofe that Hear, and the Blind of Colours as thofe that See.*

Anfwer. The Blind and Deaf have a Capacity to judge of Colors and Sounds, as well as thofe that See and Hear; tho' they want the Senfes of Seeing and Hearing : Or becaufe the Paradox refers us to the *Continent* of AFRICA, perhaps none of them have any Judgment in Colors or Sounds, as may appear by their harfh Jargon in Speech and Mufick. and profound Ignorance and Stupidity in any Thing that is curious; as in *ÆTHIOPIA, exterior,* there be Cannibals, which are fo extreme nafty and bruitifh, that they have nothing, fave the Shape of Men, to lay Claim to the Character of rational Creatures: They fmear themfelves with ftinking Greafe, their Cloak is a Sheep's Skin juft flead, and their Ribbons and Stockings are the Guts which they frequently feed on. as well as Human Flefh; yea and themfelves, tho' fo bruitifh and fwinifh, ferve, as good Pork to the *Cabona'i,* a worfe fort of Cannibals, if poffible.

30. *There*

30   *There are certain People in* South
AMERICA, *who are properly fur-
nished with only one of the five Senses,* (i. e.)
*that of Touching ; and yet they can both hear,
see, taste, and smell, and that as nicely as we
Europeans, who have all the five.*

Answer, All the Senses are properly by the Touch:
In Seeing. the Object touches the *Retina* ; in Hear-
ing, the Sound touches the *Drum* of the Ear ; in
Smelling the Effluvia's touch the *Senforium* ; in Tasting,
the *Palate, &c.*

Or, tho' they may have them, yet (as in the last
Paradox) they being so bruitish. and not knowing
them neither the right Use or Exercise of them, they
may be said, not to be properly furnished with them;
like us *when asleep,* yet when taught they can use them
as nicely, as we *when awake* ; so they have them in *po-
tentia.* as a Child : yet not *in actu,* as when grown up
before they be taught by others.

31.   *There is a certain Country in* South
AMERICA, *many of whose savage
Inhabitants, are such unheard-of Cannibals,
that they not only feed upon Human Flesh,
but also some of them do actually eat them-
selves, and yet they commonly survive that strange
Repast.*

Answer, If they don't eat (*their Meat*) themselves,
who can eat for them, in such a manner as to sustain
their Life ; or they may be such Brutes and Cannibals
as to eat their Wives, Husbands or Children, which
may be said to be Part of themselves, as being one
flesh and proceeding from them.

32. *There*

32. *There is a remarkable River on the*
Continent *of* E U R O P E, *over which*
there is a Bridge, of fuch a Breadth, that
above three thoufand Men, a-breaft may pafs
along the fame, without crowding one another
in the leaft.

Anfwer, The River *Guadiana,* betwixt *Andalufia* and
Portugal, formerly called *Anas,* hides itfelf wholly at
the Town *Medelina.* and about thirty-two Miles
Diftance fhews it felf again ; and *Alpheus,* a River
of A C H A I A, runs under the Ground and
Sea all the Way to S I C I L Y, where the
Grecians fay, is rifes again, and is called *Arethufa* ; be-
caufe every fifth Year, it cafts out the Dung of the
Cattle that was thrown into *Alpheus,* at the Time of
the Olympic Sacrifices; therefore the Land over either
of them may not improperly be called a Bridge : Al-
fo in the County of *Warwick* there is fuch a Bridge
On a Common, near *Over Ichington,* is a Pool whofe
Sream entereth the Ground, and after an intricate
Paffage. of half a Mile, cometh out again, and paffeth
along the Brook.

33. *There is a large and fpacious Plane,*
in a certain Country of A S I A, *able to*
contain fix hundred thoufand drawn up into
Battle-Array ; which Number of Men being
actually brought thither, aud there drawn up,
it were abfolutely impoffible for any more than
one fingle Perfon to ftand upright upon the
faid Plane.

Answer, According to E U C L I D, a Plane can touch a Sphere only in one Point, call'd the point of Contact, and that Person only who stands to that Point; with respect to the Center of that Sphere) can stand upright, and whereas the sensible Horizon changes, as oft as we change our Place, because of the Convexity of the Earth's Perifery.

See Euclid, *by* W. Whiston, *Lib.* 1, 19, *and* 3, 2, 16, 37. *in their Consectaries.*

And suppoling each Man to stand, as Perpendicular as a Plumb Line to his own *Horizon*; and seeing 'tis an undoubted Axiom, that *all heavy Things tend towards the Center of the Earth,* where all Perpendicular Lines, if extended, would meet.

These Things conlider'd, I say, 'tis abfolutely impossible for two Men to stand Perpendicular, to the same Plane; without contradicting the Axioms aforefaid; for could they stand Perpendicular, then would they be Parallel to each other; and were Parallels extended to the Center of the Earth, they would never meet, as all Plumb Lines so extended would.

'Tis true, this intellectual Truth is eafily demonstrated *to the Mind,* tho' not so eafiy to be mechanially prov'd to *the Eye*; becaufe the Height of a Man bears no *fenfible* Proportion to the Earth's Semidiameter. This is the longer infifted on for the Sake of the following *Paradox.*

34. *There is a certain* European City, *whofe Buildings being generally of firm Stone, are (for the moft part of a prodigious Height, and exceeding ftrong; and yet 'tis moft certain, that the Walls of thofe Buildings are not Parallel to one another, nor Perpendicular to the Plane on which they are built.*

<div align="right">*Anfwer,*</div>

<div align="center">C</div>

Anfwer. All Walls are endeavoured to be built per
pendicular to the Tangent and point to the Center
of the Earth; where they. if continued, would meet
in a Point; but if extended to the Moon and Stars
would grow wider and wider afunder, the nearer they
approach'd them; and confequently are not Parallel
which, if infinitely extended; would never meet
nor part further afunder, but keep ftill the fame Equi
diftance: Alfo in one Point only can a Perpendicular
to the Earth be raifed on an horizontal Plane, as ap
pears by the laft *Paradox.* But to be more particular
'Tis not improbable our ingenious Author might
in this *Paradox* intend the City of *Edinburgh* noted
for ftrong, high, and Stone Buildings; fome being a
is reported, fourteen Stories high, built on an Hill
and therefore the Walls are not perpendicular to the
Plane of the Hill, but to the Bafe of it; and the
Walls are not parallel to each other, for the Rea
fons aforefaid.

35. *There is a certain City, in the* Southern
Part of China, *whofe Inhabitants (both Male*
and Female do obferve almoft the fame Pofture
and Gate in Walking as we Europeans; *and*
yet they frequently appear to Strangers as if the
walk'd on their Heads.

Anfwer. In CHINA (or any other Places where
the Inhabitants ftand near the Sea) Strangers looking
in it muft fee them, as tho' their Heads were down
ward, by the refracted Vifion; Or CHINA be
ing fituate almoft in oppofite Meridians to us; an
therefore to Strangers in Geography, to tell them
there are People walking with their Feet toward
ours. they will ask (according to the Appearance
the Thing to them) do they then walk on their Heads

for our own are uppermoft, and their Heads muft be under our Feet: Then whereas the *Globe* being round, all our Heads are next Heaven, and Feet next the Earth, and no upper nor under on the *Globe*, any more than on a Wheel in Motion.

36. *There are ten Places of the Earth, di-ftant from one another three Hundred Miles and upwards, and yet none of them hath either Longitude or Latitude.*

Anfwer. The Places are faid to be *of the Earth,* not *upon the Earth*; for Longitude and Latitude are reckon'd on the Surface of the *Globe* only; fo the *Axis* of the Earth, or any other imaginary Line, being above feven thoufand *Italian* Miles will not only anfwer this *Paradox*; but inftead of ten, if he had faid twenty, it would have kept within the Poffibility of the Demand.

37. *There are two diftinct Places of the Earth lying under the fame Meridian, whofe Difference of Latitude is fixty Degrees com-pletely; and yet the true Diftance, betwixt thofe two Places, doth not really furpafs fixty* Italian *Miles.*

Anfwer. The two *Places,* are not meant on the Super-ficies of the Earth, as you may perceive by the Word *of* (and not *upon*) fo the Places will be fo near the Center of the Earth, as two Lines, fuppofed to come one from no Degree of Latitude, the other from fixty Degrees of Latitude, and to meet in the Center, may approach within the Diftance of fixty *Italian* Miles. Or the Places muft be on the *Globe* of the Earth, we muft diftinguifh between Latitude when apply'd to a Country, and when apply'd to a City; the laft, is

C 2   the

the Diſtance of that City from the Equator, *North* o
South, the firſt is only the Breadth of a Country fro
Eaſt to *Weſt*: Thus, the two Countries may be *Ita*
and *Germany*, which lye under the ſame Degree o
Longitude; the Breadth, or Latitude of *Germany*, i
ſaid to be five hundred and ten Miles, and the Bread
or Latitude of *Italy*, is ſaid to be an hundred and thi
ty four Miles, their Difference of Breadth, or Latitud
is three hundred and ſeventy ſix Miles, or above ſixt
Degrees; and yet *Italy* is not ſixty Miles diſtant fro
Germany, for they are parted but by the *Alps*.

38. *There are alſo two diſtinct Places*
the Earth, lying under the Equinoctial Lin
whoſe Difference of Longitude is complete
eighty ſix Degrees; and yet the true Diſtanc
between theſe two Places, is not full eighty f
Italian Miles.

'*Anſwer.* As in the laſt, ſo in this, the Longitude o
a City is its Diſtance *Eaſt* or *Weſt* from the firſt Me
dian; but the Longitude, or Length of a Country,
its Diſtance from *North* to *South*; Thus, ſuppoſe th
Iſle of St. *Thomas*, whoſe Longitude, or Length is n
above a Degree and an half, and the Country o
ÆTHIOPIA EXTERIOR. which is above nine
Degrees long, reckoning its Length down from *Nub*
to the Cape of *Goodhope*, and up all along the Coaſt o
Zanguebar; wherefore the Difference of Longitude, o
Length, may be ſaid to be completely eighty ſix D
grees and an half, and yet the true Diſtance of t
ſaid Iſland, from the ſaid Country, is not much abov
a Degree: Or the Places are not ſuppoſed on the Su
face of the Earth, but nearer to the Center, whe
the Longitudes all coincide.

39. *There are three diſtinct Places of the Earth, all differ both in Longitude and Latitude, and diſtant from one another two thouſand Miles completely, and yet they do all bear upon one and the ſame Point of the Compaſs.*

Anſwer. All Places, though they differ both in Longitude and Latitude, at what Diſtance ſoever, with reſpect to either Poles, bear upon the ſame Point of the Compaſs or they may be in the ſame Spiral Rumb elſe underſtood as in *the Earth,* and not up it. For to an Eye ſituate under the $\begin{Bmatrix} North \\ South \end{Bmatrix}$ *Pole,* all Places, howſoever ſituated, will bear on the $\begin{Bmatrix} South \\ North \end{Bmatrix}$ Point of the *Compaſs* becauſe every Azimuth is a Meridian, and the *Pole* and *Zenith* coincide, as aforeſaid.

40. *There are three diſtinct Places on the Continent of* EUROPE, *equidiſtant from one another (they making a true equilateral triangle, each of whoſe Sides doth conſiſt of thouſand Miles) and yet there is a fourth Place ſo ſituated, in reſpect of the other three, that a Man may travel, on Foot, from it to any of the other three in the Space of one Artificial Day, at a certain Time of the Year, and that without the leaſt Hurry or Fatigue whatſoever.*

Anſwer

Anſwer. By an artificial Day, is meant from Sun-riſing to Sun-ſetting: Now beyond the Polar Circles, and nearer to the Poles, the Days are encreaſed from Twenty four Hours to ſix Months, without Sun ſetting under the Poles, in which Time, one may travel above Four Thouſand Miles and travel only a Mile an Hour one with another.

Or Suppoſe the three Places to be in *SWEDEN NORWAY* and *MUSCOVY*, where their Day is about Two Months long near the Summer-Solſtice, let the fourth Place be equi-diſtant from the other three: Now if the Sides of an Equilateral Triangle be one thouſand, the Radius of its Circumſcribing Circle will be five hundred ſeventy ſeven Miles: and if a Man travels but ten Miles a Day, he may readily travel from the Center of the Triangle to any of thoſe three Places in one ſuch Day.

41. *There are three diſtinct Places on the Continent of* EUROPE, *lying under the ſame Meridian, and at ſuch a Diſtance, that the Latitude of the third ſurpaſſeth that of the ſecond, by ſo many Degrees and Minutes, exactly, as the ſecond ſurpaſſeth the firſt; and yet the true Diſtance of the firſt and third, from the ſecond or intermediate Place, is not the ſame by a great many Miles.*

Anſwer. The oblate ſpheroidical Figure of the Earth may cauſe ſuch a Difference. Or ſuppoſe *London, Paris* and *Bourbon,* all under the ſame brazen Meridian, equally different in Latitude; yet the Diſtance of *London* from *Paris,* will exceed the Diſtance of *Bourbon* from *Paris,* by near an hundred Miles; becauſe *London* is about two Degrees *Weſterly* off *Paris,* about the Breadth

f the Brazen Meridian; whereas *Bourbon* and *Paris* are
n the fame Longitude, and confequently nearer, by
lmoft two Degrees.

42. *There are two diftinct Places on the*
Continent of E U R O P E *fo fituated, in re-*
fpect of one another, that tho' the firft doth lye
Eaft from the fecond, yet the fecond is not Weft
from the firft.

Anfwer. If any two Places be in the fame Parallel of
Latitude, refpecting the Rumb, the firft may and muft
bear off the fecond *Eaft* and *Weft*; and yet the fecond,
refpecting the Angle of Pofition, or the Bearing of one
Place from the *Zenith* of the other, on the *Globe* may
be far fhort of being due *Weft*, as *Lisbon* in *Portugal* and
Smyrna in *Natolia*, are in the fame Parallel of Latitude,
.e. thirty nine Degrees, and therefore, by the Rumb,
they bear *Eaft* and *Weft*. But on the *Globe*, *Smyrna* bears
off the *Zenith* of *Lisbon* feventy five Degrees *North Eaft*,
and *Lisbon* bears off the *Zenith* of *Smyrna* eighty Degrees
South Weft, which is evident from the Globe and Circle
failing.

Note, A Rumb Line makes equal Angles with all
Meridians on the Globe; and an equal Part thereof
altereth the Latitude equally : But in the Circle of
Pofition makes unequal Angles, *i. e.* greater Angles
with all other Meridians than with that from which
it was drawn.

43. *There is a certain* E U R O P E A N
Ifland, the Northermoft *Part thereof, doth*
frequently alter both it's Longitude and Lati-
tude.

　　　　　　　　　　　　- *Anfwer.*

Anfwer. By *European* Iſland, may be meant either
the Map of it, as *I C E L A N D*, whoſe *North* Part
thereof, uſed to be ſet above the Artic Circle, but
now is below it, and nearer the *Eaſt.* Or the Iſland
it ſelf; then it muſt mean ſome floating Iſland, as *Boe-*
thius tells us, there is one in *Lomond*, the biggeſt Lake
in *Scotland*; which alſo our ingenious Author menti-
ons, as one of the Rarities of *Scotland*; in which Lake
are alſo Fiſhes without Fins, and is frequently tem-
peſtuous in a Calm: Or any Iſland, whoſe *North-Eaſterly*
Part is overflow'd by the Sea; this will alter both its
Latitude and Longitude.

44. *There is a certain Place in the Iſland of*
Great-Britain, where the Stars are always vi-
fible, at any Time of the Day, if the Horizon
be not over-caſt with Clouds.

Anſwer. That Place may be ſome Coal-pit, Well,
deep Cave, or high Chimney, or Dr. *Halley's Royal Ob-*
ſervatory; ſuch as *Tycho* had at *D E N M A R K*; which
was a deep Well or Dungeon, beſet with Looking-
Glaſſes, where he ſat and obſerv'd the Stars in all
Seaſons.

45. *It may be clearly domonſtrated by the*
Terreſtrial Globe, *that it is not above Twen-*
ty Four Hours Sailing, from the River Thames
in ENGLAND, *to the City of* Meſſina *in*
SICILY, *at a certain Time of the Year; pro-*
vided there be a brisk North *Wind, a light*
Frigate, and an Azimuth Compaſs.

Anſwer. Nor Twenty Four Hours neither, if
the Voyage be performed on the Globe, and the
Time meaſured by its Hour Index; Or if it mean
the

the Tides failing betwixt thofe two Places : Or becaufe one may pafs from *France* to *Italy* by Land, and the Sailing betwixt *Britain* and *France*, alfo *Italy* and *Sicily*, is not above twenty four Hours.

Or if by twenty four Hours, be meant the natural Day under the *Poles*, which is a whole Year, this Voyage may be perform'd more than once in that Time.

Or, Laftly, the Difference betwixt the *Julian* and *Gregorian* Accounts being eleven Days. whereunto add another, which makes twelve ; a Time fufficient for fuch a Voyage ; provided you have, ftill, a good Wind, light Frigate. and proper Inftruments. This may eafily be demonftrated by the Terreftrial *Globe*, on whofe *Horizon*, both Accounts are laid down.

" Thefe (adds our Author) are the chief Paradoxical Pofitions, in Matters of Geography, which mainly depend on a thorough Knowledge of the *Globe* ; and though it be highly probable that they will appear to fome, as the greateft of Fables, yet we may boldly affirm, that they are not only equally certain, with the (aforefaid) Theorems ; but alfo we are well affured, that there's no Mathematical Demonftration of *E U C L I D*, more infallibly true in it felf. than is every one of them.

Howbeit, left fome of the foregoing Solutions fhould not anfwer the Dignity of this Encomium or Character , hear what the fame ingenious Author, who doubtlefs knew his own Senfe beft, acknowledges in his Preface.

" If therefore thefe P A R A D O X E S; above-mention'd. fhall obtain the End propos'd (the roufing of the *Mind* to *Think*) it matters the lefs, if fome of them. upon ftrict Enquiry, fhould be found to confift of equivocal Terms, or, perhaps, prove little more than a Quibble at the Bottom. " To which I fubjoyn, If any of the preceding,

preceding Anfwers feem not fufficient, or fatisfac
tory, I defire our Author's End may be ftill pur
fued : May it roufe the Mind of my judicious
Reader, to *Think*, and offer a better ; according t
the Saying of the Poet, with which I conclude th
firft Part.

——*Si quid novifti rectius iftis,*
Candidus imperti ; Si non, his utere mecum.

PART II.

NEW
PARADOXES
SOLV'D

46. **I**N what Degree of Latitude
    Does that foft Female dwell,
    Who. upon certain Days, might view,
    If fhe obferveth well,
The Morning Sun o'th' felf fame Point
  Of Compafs twice to be,
Likewife his Evening Azimuth
  Twice in the fame Degree.
Tell me fweet *Englifh* Ladies for you are
  Than her more charming far, and far more fair.

Anfwer, Between the *Tropics*. See Paradox 12.

47. In the *Atlantic* Ocean, from our Shore
Diftant five hundred Leagues, or little more,
Lie the *Canary* Ifles, bleft with good Air,
Sweet whiftling Birds, rich Wines beyond compare.
A Mountain, the World's Wonder, fituate there.
                               One

One of higheſt in this earthly Sphere;
By us 'tis call'd the *Teneriffa's Pike*,
Whoſe lofty Head i' th' Atmoſphere's ſo high,
That it ſurmounts all groſſer Clouds o' th' Sky;
Three Degrees and half you may it ken,
Or (what's the ſame) two hundred Miles and ten;
For the Refraction, Angle you may make,
Allowance (what is thought but meet to take)
Thirty-five Minutes, juſt of a Degree:
Now I demand what Height the Pike muſt be.
     Anſwer, 4. 28. Miles high.

48. I have twelve Times ſeen *Biſſextile,*
Pray tell how that can be,
Since twelve times four make forty eight,
And I'm but forty three.

     Anſwer, If a Perſon be born on the 25th of *February,*
and travel *Weſtwards* the *Globe* about, he may ſee twelve
Biſſextile Years before he he completely forty four Years
of Age, if he was born in a *Biſſextile* Year.

49. A Golden Ball ſhall weigh two Pounds in *Troy,*
Where from th' Æquator ten Degrees does lye;
But at *London* a different Weight is found,
Of that ſmall Ball, which Difference pray expound.

     Anſwer, The Earth is not exactly round; but its Di-
ameter at the Equinoctial Circle, is, to its Diameter
thro' the *Poles,* as ſix hundred ninety two to ſix hun-
dred eighty nine; therefore, according to the incom-
parable Sir *Iſaac Newton,* the Proportion of Gravity, be-
twixt the *Æquator* and *Poles,* is as five hundred to five
hundred and one, and the Increaſe, near as the Square
of the right Sine of the Latitude; and that the Ball
would weigh more at *London* than at ten Degrees Lati-
tude, by thirteen Grains.

This then is (I preſume) occaſion'd from the Earth's
oblate Figure, and the Diminution of the centri-petal
Force or Gravity, which is univerſal, 1. In every ſingle
Particle of Matter. 2. As to its Extent. 3. As to all kind
of Bodies. 4. As to Time. 5. As to Quantity of Matter.
6. In a duplicate Proportion to their Diſtances.

50. *Die quibus hoc Animal Terræ naſcatur in Oris;*
Maſculus eſt mater cui Mulierque pater.

Anfwer.   Progenitos vidi numerofos vere Gyrinos
             Hæc rana, hic Bufo, Mater hic, illa Pater.
A Tadpole, young Frog, or Toad.

51. *Leander* to his *Hero* writ, and fhe
s oft writ back, to fhew her Conftancy;
Vhen with them both the Poft three Times had been,
hey had no more than each a Letter feen.

Anfwer.   The Paradox means with both not each
ree Times: The firft, Poft took *Leander's* Letter, fe-
nd *Hero's* Anfwer, and third brought it to *Leander*.

52. The Day that I was born, my Father he
aid by five Pounds, and faid it was for me;
nd whene'er my Birth-Day came, he ne'er fail'd
o add five Pounds, (his Love fo much prevail'd)
t twenty four, and upon my Birth-Day,
wedded was, my Portion he would pay,
ft thirty five Pounds (I full twenty four)
ow comes it then my Portion was no more.

Anfwer.   The Perfon was born in *Leap-Year*, on the
th of *February*.

53. A certain Mount in *Devonfhire* doth ftand,
hofe lofty Head o'erlooks the neighb'ring Land;
nd fuch is the known Property o'th' Hill,
at if a Veffel you with Liquor fill.
the Hill's Top, or Vertex of the Place,
holds lefs than if filled at the Bafe:
ow what's the Caufe of this Deficiency,
ay let me know in the next Diary?

Anfwer.   Water has its Surface alw:ys of a fpherical
ure, and that fartheft from the Earth's Center is
ft Swelling, and confequently holds leaft above the
im of the Veffel: The Top Diameter of the Veffel
ng the Chord of a greater Circle, on the Top of
high Hill than at the Bottom, which is a fomewhat

D   lefs

leſs Circle, and conſequently more Convex, will
therefore hold more above the Brim, at the Baſe, than
at the Top of the Mountain.

54. When Tyrant *Noll*, ar fatal *Worc'ſter* Fight,
His Crew harangu'd, againſt both Law and Right,
His quaint numerique Voice no two did hear,
Tho' ſeveral thouſand Miſcreants were there;
For ev'ry Man, and ev'ry ſeveral Ear,
Did not the ſame, but diſtant Voices hear.

Anſwer. Sound being efflated in Concentric Circles,
as a Stone falling into Water, moves it all around;
ſo that Part of the Circle, which touch'd one Man's
Ear could not touch another's, who could not be in
the ſame individual Spot of Ground.

55. By what Means may I know moſt certainly,
That two Men in the World there are,
Whoſe Heads of Hair, (if numbered they be)
Are equal to a ſingle Hair;
Altho' ſome Millions on each Head there were.

Anſwer. If the Number in the World, do exceed
The Number of Hairs that are on a Man's Head,
You may ſafely affirm then, that two Men there are
That have the ſame Number to a ſingle Hair.

To explain and prove the Truth of this Hypothe-
tical Propoſition; That if there be more Perſons in
the World than the Number of Hairs on the Head of
any one alive, then muſt there be two Men in the
World, the Number of Hairs of one of whoſe Heads,
is exactly equal (to a Hair) with thoſe on the other's
Head.

Suppoſe a very ſmall Number of Men, for Inſtance
eight, and the Hairs on none of their Heads exceed
ſix; the ſame Conſequence will follow by the ſame
Ratiocination, as if you made Uſe of a greater.

Next, Suppoſe one of theſe eight has but one Hair,
if any other of the ſeven have only one Hair; we have
already

already found out what we defir'd; if not, fet this
Man by, and out of the feven remaining, chufe ano-
ther, which we fuppofe has two Hairs; now if any
one of the other fix hath two Hairs, and no more, we
have what we fought for; but if not, fet this Man a-
fide, and take another, out of the fix remaining Men,
which we fuppofe has three Hairs; if then any of the
other five has got three Hairs, as well as he, our En-
quiry is at an End; if not, fet him afide, and chufe a-
nother out of the five, which we fuppofe has four
Hairs; if any of the other four fhould chance to
have four Hairs, then have we two Men that have each
an equal Number, the Thing fought; if not, then
they all four muft have either five or fix Hairs; for be-
yond fix no Man can have : Then put this Man by, and
take a fifth, whom we fuppofe to have five Hairs; now
if any of the other three have five, we have our De-
fire; if not, then it follows, that the three remain-
ing Men, muft of Neceffity, have each Man fix Hairs;
for before we have proved that they had neither one,
nor two, nor three, nor four, nor five, and therefore
they muft have fix, beyond which they cannot exceed.

Now, if inftead of fuppofing the firft Man had one
Hair, you had fuppofed he had fix, five, or four, *&c.*
you would by the fame Way of Arguing, come at laft
to the fame Conclufion.

56. *Phillis*, the fhy and fcornful fair,
Was by brave *Strephon* held moft dear,
But ftill, as he preft on his Joy,
She grew more malepert and coy;
And when he talk'd of Marriage to her,
She got more diftant from her Wooer.
But what he fu'd for, thus, in vain,
He did by Accident obtain;
For walking with his *Phillis* dear,
One Afternoon, to take the Air,
In a vaft Champain Country. where
Nor Hedge, nor Houfe, nor Tree were near,
When ftrait dark gloomy Clouds appear,
Which did prefage a Storm was near.

Anon

Anon (no Shelter being nigh)
It rain'd and blow'd impetuoufly :
Which made the fhy Dame him invoke,
To fhelter her with his long Cloke.
Soon after this the Storm grew higher,
Which made the Nymph cling ftill the Nigher :
Then roar'd around them Peals of Thunder,
As if the Earth had burft afunder.
This made the trembling Maid embrace,
And in his Bofom fhroud her Face.
The Swain, tho' almoft ftun'd with Fear,
Being thus warmly clafp'd by's Dear,
Took Courage, and to her thus fpoke,
Phillis, I all the Gods invoke,
To witnefs that my Paffion's true,
And would forego the World for you ;
No Flattery I need pretend,
For furely now the World will end.
Oh *Strephon!* (cries the trembling Fair)
My Thoughts I'll tell you without Fear ;
I Love as much, as dear as you,
But Pride forbids what Love did fue ;
And if this dreadful ftorm blow o'er,
I ne'er will perfecute you more.
Then did they intermingle Kiffes,
A fure Prefage of future Bliffes.
Straightway the Heav'ns began to clear,
And Joy fucceeded now their Fear.
This was, as I do well remember,
About the fifth Day of *December*.
They then agreed to be in Wedlock join'd,
The longeft Day he in the Year could find ;
And in the following Week the Marriage was,
Pray tell me now, how this could come to pafs.

Anfwer. From Noon to Noon, *Aftronomers* do fay,
Are not juft twenty four Hours ev'ry Day,
But longer fome, fome fooner hafte away.
Good *Pendulums* as I do well remember,
About th' eleventh or twelfth Days of *December*,

The Space of thirty Seconds, meafure more
In Number than they did the Day before;
But no Days elfe, which plainly make appear
That thefe the longeft are in all the Year.
Strephon rejoyc'd, that he fo foon had found
The Day on which his nuptial Joys were crown'd,
Fair *Phillis*, too, tranfported with Delight,
No lefs rejoyc'd it prov'd the longeft Night.

Some Reafons follow, ferving to explain the foregoing Solution.

1. If the Sun or Earth moved along the Equinoctial,
by a conftant, uniform, equal Motion; yet the Time,
from Noon to Noon, would not be exactly twenty
four Hours, but twenty four Hours four Minutes;
becaufe in one Revolution the Sun would advance a-
bout one Degree further than the Day before.

2. If the Sun be fuppofed to move equally along
the Ecliptic; yet, becaufe of its Obliquity, equal Ar-
ches of the Ecliptic would not anfwer to equal Ar-
ches of the Equinoctial.

3. The Sun doth not move with a conftant, uni-
form, equal Motion, in the Ecliptic, but fometimes
fafter and fometimes flower; becaufe it moves in an
Ellipfis; and in going one Half of it fpends eight
Days more in the *Summer* than in the *Winter* Half-Year
Therefore it unavoidably follows, that the Days are
unequal, and not exactly twenty four Hours.

57. A Landed Man two Daughters had,
And both were very fair,
He gave to each a piece of Land,
One round, the other fquare:
At twenty Shillings an Acre, juft,
Each Piece its Value had,
fay, The Shillings which did compafs each,
For it exactly paid.
If crofs a Shilling be an Inch,
(As it is very near)
Which was the better Fortune. She
That had the Round or Square?

Anfwer

	l.	*s.*	*d.*
Answer. The Value of the {square / round} Piece is	12545	5	7½
	9853	0	9¾
Difference	2692	4	9¾

The *Algebraic* Procefs is,

The Perches English *Meafure*

In the Square.

a = Nr. of Shillings that purchas'd it.

a = Nr. of Inches about the 4 fides.

n = Nr. Inch. in fqu. acre = 6272640

f = Nr. Shillings that purchas'd an Acre

Then $\dfrac{a}{4}$ = one fide which

fquar'd gives $\dfrac{aa}{16}$ which are the fquare Inches the Clofe this divided by

n gives $\dfrac{aa}{16n}$ the Nr. of Acres, which multiplied

by f gives $\dfrac{aaf}{16n}$ = a the Whole Value of the fquare Piece in Shillings, and being reduced gives

$a = \dfrac{16n}{f} = 12545. 5. 7$

In the round Piece.

a = Circumference in Inches.

a = Nr. Shillings that purchas'd it.

d = Diameter of the Circle = 1.

e = Circumf. of faid Diam. 3. 14159

Then fay

As c to 1 : : a : $\dfrac{a}{c}$ =

Then ½ Circumference into ½ the Diameter gives the Area.

$\dfrac{a}{2} \times \dfrac{a}{2c} = \dfrac{aa}{4c}$ Area.

This Area, divided by n, and multiplied by f, as in the former gives the Purchafe in Shillings, viz.

$\dfrac{aaf}{4cn}$ = a which reduced is $a = \dfrac{4cn}{f} = 5853 : 0 : 9¾$

58. Suppose a round Ball for to move in the Air,
n a certain Proportion, which I shall declare ;
et the first Hour be twelve Miles, the next to move
nd so in Proportion from whence it began,   (ten,
s twelve is to ten.   Now try if you can
ell the Miles it will move, suppose it to be
ontinued in Motion to Eternity.

Answer.   The Ball that is moving *Eternally* so
n Proportion of twelve to ten justly will go,   (*&c.*
hreescore and twelve Miles, and no more. I declare,

The Reason of this Paradox is, that in infinite Geo-
netrical Progression, if the Proportion do continu-
lly decrease, the last or least Term will be infinitely
mall, or, in Effect, nothing, and so produce a finite
umber.

ppose $\begin{array}{l} A = first\ or\ greatest = 12 \\ B = second\ Term\ \ \ = 10 \end{array}$ it will be $\dfrac{AA}{A-B} = Sum\ of\ all$

e Terms $= 72$.

59. If, in one's Second's Time, an Iron Ball
id five and twenty *English* half-Feet fall :
ow long must be the Time it then must take
Journey of ten thousand Miles to make ?

Answer.   I think the Time in which the Iron Ball,
f gently dropt, ten thousand Miles will fall,
ust be allow'd in Minutes thirty four,
nd Seconds nineteen, neither less nor more.
But it falls 10000 *Irish* Miles in 38 Minutes 38 Se-
onds.
This depends on the following Proposition, that
he Acceleration of the Descent of heavy Bodies, are
the Square of the Times ; the Reason is, the Action
f Gravity being continu'd in every Space of Time,
he falling Body receives a new Impulse equal to
hat it had before, in the same Space of Time, receiv-
d from the first Power.

Thus

Thus, Suppose in the firft Second of Time a Body hath acquired a Velocity, which, in that Time, would carry it thirty two Foot (and were there no new Force it would continue to defcend, at that Rate, with an equable Motion) but, in the next Second of Time, the fame Power of Gravity, continually acting thereon, fuperadds a new Velocity equal to the former; fo that at the End of two Seconds, the Velocity is double, to what it was at the End of the firft.

Hence, then, the Queftion is eafily folv'd; for turn the Miles into Feet 52800000 and divide it by 12 .. 5, the Quotient is the Square of the Seconds the Body will be falling (viz. 4224000) the Square-Root whereof, gives Seconds (2059) and dividing by 60, gives Minutes, namely 34 : 19 Seconds a little above half an Hour.

60. Before my Father was begot,
·I'm fure I was begotten
And born before my Mother,
They are both dead and rotten:
And I am lying in that Bed
Where I got my Grandmother's Maidenhead.

Anfwer. *Adam*, I know, was ne'er begot,
And *Eve* of him was made,
And fince by him they brought in Death,
They both, long fince, are dead,
'Tis certain, *Abel* was begot
Of thofe his two faid Parents,
He dy'd by Force, and was the firft
That yielded to Death's Warrants:
Therefore he got the Maidenhead
Of's Grandmother, the Earth,
Being laid therein the firft that was,
Tho' not the firft by Birth.

61. I. As I was mufing all alone,
What Paradox to pitch upon,
To entertain the Fair,
Within my Study flies a Bee.
Whofe Wings made pretty Melody,
·As ever I did hear.

II. Pleas'd

II. Pleas'd with the Noife, I drew more nigh,
When inftantly came in a Fly,
    That charm'd me with her Sound;
The then united Tones produc'd
A perfect fifth as e'er was us'd,
    Or could by Art be found.

III. The nimble Fly's Wings quicker were
Than thofe of her Competitor,
    As may by this appear;
For an acuter Tone they made,
And in a fharper Key they play'd,
    (Which made the Matter clear)

IV. If in a Minute's Time, thought I,
The nimble Wings of this fame Fly
    Ten thoufand Beats did go:
What Number then muft be the Swings
In two Hour's Space, of the Bee's Wings?
    Is what I fain would know.

Anfwer. Believe me, Sir, the little Bee,
    With her harmonious Wings,
Did make exact, in two Hours Space,
    Eight hundred thoufand Swings.
The Foundation of this depends upon the Divifion
of a Monochord, *&c.* Divide the String of a Viol into
three equal Parts, and then ftrike the whole String
(and obferve the Sound) ftop the String again, in one
of the third Parts, and ftrike the Length that hath two
Parts of the whole open; it will found a perfect Fifth
to the former Tone; fo that the Proportion is as
three to two; fo is the Diapafon to the Diapente, or
the Muficians Eighth to their Fifth: So that the Para-
dox is eafily anfwer'd; for as three to two, fo is the
Number of Vibrations that the Fly makes, in two
Hours, to the Number which the Bee makes in the fame
Time, *viz.* 800000.

62. I once effay'd (but 'twas in vain)
    To win the Prize propos'd,
Howe'er I'll venture, once again,
    'Caufe merrily difpos'd.

The

The Mark whereat I now do aim;.
  The promifed Reward,
Eggs me to play a forced Game,
  And draw my only Card;
Aftonifhing it fure muft be
  As Paradox e'er was,
And thro' Surprize you fcarce can fee
  How it fhould come to pafs;
That I, the only Offspring, then,
  Was marry'd to my Mother,
And yet fhe never marry'd Man,
  Nor ever took another,
Nay, ftill a ftranger Thing you'll find,.
  That when I wedded was,
I then was of the Female kind,
  My Mother was the Mas;
Yet the moft fruitful Wife ne'er had
  So many Sons as I;.
'Tis hard, methinks, to be conceiv'd,
  Tho' fpoke without a Lye.
But know. the Cream o'th' Jeft is here,
  No Body was my Father;
Then wonder, yet, how't may appear
  That ever I had Mother.
How could it ever happen fo,
  I'll have you all to guefs,
And yet, perhaps, you can't find who
  My loving Husband was.
Here. Ladies, you may ruminate,
  And ftill remain in Doubt,
Which, if you can't inveftigate,
  I'll dare to make all out.

  Anfwer. Your Paradox muft needs furprize.
    And much delight the Fair,
  I think you merit well the Prize,
    For 'tis beyond Compare,
  Aftonifh'd I found out at laft
    Your Meaning muft be *Eve*,
  Being taken out of *Adam's* Wafte
    Did Female fhape receive,

The only Offspring then fhe was
  And *Adam* was her Mother
She Woman was, and he the Mas
  Yet was he not her Father,
A fruitful Wife fhe was, 'tis plain
  Unto her Husband Adam;
Her eldeft Son we read was *Cain*
  God knows a very bad one,
Your Paradox thus I've explain'd
  And think 'tis an hard one,
The Truth I hope, I have obtain'd
  If not, I beg your Pardon.

63. Walking the other Day, to take the Air,
Bright fhone the Sun, the Weather very fair)
At Diftance I a difmal Cloud did fpy,
Which (as methought) againft the Wind did fly.
While I upon my Watch did look, to fee
How Time did pafs away, lo, inftantly
A dreadful Flafh of Light'ning pierc'd the Cloud,
Juft fourteen Seconds, after which, aloud
The Thunder roar'd, now I inform'd would be,
How many Feet the Cloud did burft from me.

Anfwer. When Heat, and Moifture, are in one con-
      join'd,
And fable Mountains chac'd before the Wind,
When two Contraries were together pent,
Their inbred Jarrs, foon fhew'd their Difcontent.
Then mighty *Jove*, to fcourge their Mutiny,
Bombards their Fort with his Artillery;
Or when by Force th' embodied Cloud is rent,
A Peal of Thunder fhakes the Firmament.
See here the Diftance when that Rupture brake
When angry *Jove* thus to his Creatures fpake.
Hufh, ceafe this Rage. They ftrait are calm and ftill,
They all obey, and wait upon his Will.

According to Sir Ifaac Newton. *Sound flies* 968 *Feet in a*
fecond; wherefore 968 × 14 = 13552 *Feet, or Miles* 7, 6 *Fur-*
lings, 160 *Feet,*

                                    Perhaps

Perhaps it may not be unwelcom to the Reader t[o] deliver fome Obfervations concerning *Sound*, and th[e] *Progreffion* of it.

Sound is produc'd by the little Vibrations, which th[e] Parts of the fonorous Body occafion in the Air; an[d] the *Strength* or *Weaknefs*; in Proportion to the Quan[ti]ty of the Air ftruck, and the Strength of the *Vibr*[a]tions.

Mr. *William Derham*, F. R. S. obferves there is a con[fi]derable Difference in the Accounts given by good A[u]thors about the Velocity of the Motion of *Sound* in [a] *Second* of Time, as followeth.

Sir *Ifaac Newton's* firft Edition of Mathematical Pri[n]ciples, gives 968 Feet in a Second of Time.

His fecond Edition corrected ——— ———	11[
Francis Roberts ——— ——— ———	13[
Mr. *Bailie* ——— ——— ———	12[
Dr. *Walker* ——— ——— ———	13[
Mr. *Flamftead* Aftronomer Royal —— —— ⎫	
Edm. Halley ——— —— —— ⎬ 11[	
Mr. *Derbam*, F. R. S. —— —— —— ⎭	
Florentine Academy —— —— —— ⎫	
Royal Academy at *Paris* —— —— —⎬ 11[	

This Diverfity proceeds; probably, from not uf[ing] good Pendulums, but *Strings* and *Plummets*. 2d. Fro[m] difregarding the Winds. 3d. Diftance betwixt *Sou[nd]* and *Obfervation* too fhort. And the Difference betwi[xt] the three laft being fo fmall, might arife from uf[ing] Pendulums equally good, and Experiments equal[ly] large.

The fame worthy Author, by manifold Experimen[ts] and repeated Obfervations, found no Difference, wh[e]ther the *Gun* was fir'd towards or againft him, in t[he] Velocity of the *Sound*, nor in any different Elevatio[n] nor in different Quantity, or Strength of Powder (th[o'] it did in Strength of Noife) neither betwixt Day [or] Night, Clear or Cloudy, Winter or Summer, Rain [or] Snow: All kinds of *Sounds* came in the fame Time to h[is] Ear, from the fame Diftance, whether tenfe or ftro[ng] languid or weak.

By very accurate Obſervations, he found the Motion of *Sound* to be equable in all Reſpects; that is, an *Engliſh* Mile in 9 half *Seconds*, 2 Miles in 18, 3 Miles in , *&c.* And he is confirmed in the Belief, that *Sound* moves the neareſt Way, and its Velocity equal in Activities or Declivities, and that Difference of Climates or Weather, makes no Difference in the Velocity, though thick, cloudy or ſnowy Weather, did dull the Noiſe or Sound.

But I know not why Winds might not ſo affect Sound, that is, by conſpiring with its Motion, advance it to 1200, or retard it by its being contrary, that it may not move above 1100 in a Second of Time.

The Uſe of all this may be to meaſure the Diſtance of Thunder, Forts, Batteries, or Ships at Sea, *&c.*

Any *Space* or *Diſtance*, propoſed to find how long Sound will be flying that Diſtance, ſay,

As 1142 : is to 1 : : ſo is the Diſtance in Feet to the Time in Seconds.

Any Time propoſed to find the Space or Diſtance that a Sound will fly in that Time, ſay,

As 1 : is to 1142 : : ſo is the given Time in *Seconds* to the Diſtance in Feet.

From what has been ſaid, we may conclude, that Sound moves 1142 Feet in one *Second* 8 Miles in 37 Seconds, 13 Miles in one Minute *Fere*, and near 780 Miles in an Hour.

And if we number 10 *Seconds* between the Fire of the Cannon ſeen and the *Sound* heard, it is manifeſt that the Gun is 11420 Feet diſtant, or ſomewhat more than two Miles.

As likewiſe, if 5 *Seconds* paſs betwixt one ſeeing the Flaſh of Light'ning, and hearing the Thunder, we may reckon the Thunder Cloud is about 5710 Feet, or a little above one Mile diſtant from us.

64. Enflam'd in Love and wrapt in Extaſy,
Encircled in *Eliza's* Arms I lay;
Then envious Chance did our ſad Parting cauſe,
Againſt both Nature's and Affection's Laws;

E   But

Perhaps it may not be unwelcom to the Reader
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good Pendulums, but *Strings* and *Plummets*. 2d. Fro
difregarding the Winds. 3d. Diftance betwixt *Sou*
and *Obfervation* too fhort. And the Difference betwi
the three laft being fo fmall, might arife from uf
Pendulums equally good, and Experiments equal
large.

The fame worthy Author, by manifold Experiment
and repeated Obfervations, found no Difference, wh
ther the *Gun* was fir'd towards or againft him, in t
Velocity of the *Sound*, nor in any different Elevatio
nor in different Quantity, or Strength of Powder (th
it did in Strength of Noife) neither betwixt Day
Night, Clear or Cloudy, Winter or Summer. Rain
Snow: All kinds of *Sounds* came in the fame Time to h
Ear, from the fame Diftance, whether tenfe or ftro
languid or weak.

By very accurate Obfervations. he found the Motion of *Sound* to be equable in all Refpects; that is, an *Englifh* Mile in 9 half *Seconds*, 2 Miles in 18, 3 Miles in , &c. And he is confirmed in the Belief, that *Sound* moves the neareft Way, and its Velocity equal in Acivities or Declivities, and that Difference of Climates or Weather, makes no Difference in the Velocity, though thick, cloudy or fnowy Weather, did dull the Noife or Sound.

But I know not why Winds might not fo affect Sound. that is, by confpiring with its Motion, advance it to 1200, or retard it by its being contrary, that it may not move above 1100 in a Second of Time.

The Ufe of all this may be to meafure the Diftance of Thunder. Forts. Batteries, or Ships at Sea, &c.

Any *Space* or *Diftance*. propofed to find how long Sound will be flying that Diftance, fay,

As 1142 : is to 1 : : fo is the Diftance in Feet to the Time in Seconds.

Any Time propofed to find the Space or Diftance that a Sound will fly in that Time. fay.

As 1 : is to 1142 : : fo is the given Time in *Seconds* to the Diftance in Feet.

From what has been faid, we may conclude, that Sound moves 1142 Feet in one *Second* 8 Miles in 37 Seconds, 13 Miles in one Minute *Fere*, and near 780 Miles in an Hour.

And if we number 10 *Seconds* between the Fire of the Cannon feen and the *Sound* heard, it is manifeft that the Gun is 11420 Feet diftant, or fomewhat more than two Miles.

As likewife, if 5 *Seconds* pafs betwixt one feeing the flafh of Light'ning, and hearing the Thunder, we may reckon the Thunder Cloud is about 5710 Feet, or a little above one Mile diftant from us.

64. Enflam'd in Love and wrapt in Extafy,
Encircled in *Eliza*'s Arms I lay;
When envious Chance did our fad Parting caufe,
Againft both Nature's and Affection's Laws;

E   But

But our next Meeting, we did then affign
Seventy eight hundred Beats and twenty nine
Of a nice Pendulum, whofe Length I fee
Twenty five Inches three Eighth's exaĉt to be.

Affift me quickly, oh you Sons of Art,
You who have felt the Sting of *Cupid's* Dart,
You who to Tendernefs and Pity move,
And know the Pangs of difappointed Love;
For if, too foon or late, I chance to go,
Defpair and Ruin certainly enfue:
Tell me the Hours and Minutes, I implore,
Or I fhall never fee my dear *Eliza* more.

Anfwer. One Day as I was in a mufing Vein,
My roving Fancy did me entertain
With Thoughts of Love, which did the Time beguile,
And great Delight attended me the While.
Straitway I ftruck into a verdant Plane
To meditate, and eafe my troubled Brain;
There I efpy'd a Grove moft rich of Shade,
Where wanton Birds harmonious Mufick made:
All Things rejoyc'd in this moft lovely Green,
Nature, in full Perfeĉtion, here was feen,
I plac'd my felf under a fpreading Tree,
Methought it was a charming Canopy,
Under this pleafant Shade *Eliza* fweet,
And her dear Lover, did together meet;
Where he oft lay encircled in her Arms,
In Love-Tranfports, amidft a thoufand Charms;
But envious Chance did feparate thefe Friends,
Who hope next Meeting will make them amends.
Ah! cruel Fate, to crofs poor Lovers fo,
Methinks I feel the Pain they undergo,
Caus'd by that Traytor's Abfence, in each Breaft
With Sighs and Tears which cannot be expreft.
But left a Difappointment he fhould find
In their next Meeting, which they both affign'd,
To eafe his Pain, it doth my Pity move,
Who know the Pangs of difappointed Love.

In

In his *Eliza*'s Arms let him be bleft,
And in her pretty panting Bofom reft;
The Time is fhort, which if they chance to mifs,
It puts an End to all his Earthly Blifs;
Like a dear Lover, Love my Mind infpires,
And his hard Cafe a Tendernefs requires:
How long it is e're he *Eliza* met,
In this moft pleafant Shade, I find complete
To be one Hour, with Minutes forty four
And Seconds fifty fix, nor lefs nor more.

65. My Grandfire and my great Grandfire
  I'm fure conceived were
Both in one Inftant, at one Time
  Firft breathed in the Air.
My Grandfire did no fooner breath,
  My Father did the fame,
Great Grandfire my Father begot
  Before my Father came.
Into this World. where he did meet
  With Troubles, not a few,
My Family it did decreafe,
  I did the fame renew.
My Grandmother and Sifter too,
  Conceiv'd me, both as one:
My Aunt and Sifter, in like Cafe,
  Brought forth another Son.
Tho' Grandmother and Mother too,
  Did bear me as a Son,
My Gradmother transformed was,
  Before my Life begun
Though thus transformed, fuffered Death,
  Jofephus doth relate,
Hundreds of Years after my Birth,
  He faw it in that Eftate.

Anfwer Your Paradox I muft commend,
  Ingenious Mr. *Lover*,
And though 'tis difficult, intend
  Solution to difcover.

E 2   'Tis

'Tis *Moab*, who was Son of *Lot*,
  Your Paradox muſt anſwer,
Which of his Daughter was begot;
  If this won't do. I can't, Sir;
Lot. Grandſire and Great Grandſire was
  To *Moab* and to his Brother,
From hence, I think it comes to paſs,
  'Tis true you mean none other;
No Wonder they conceived were,
  (His Sire and Grandſire too)
Both in one Inſtant. breath'd i'th' Air
  Together, as you ſhew,
Great Grandſire *Haran* did beget
  His Father, *Lot*, we read,
In *Ur* of the *Chaldees*, he yet,
  Long e're *Moab's* Birth was dead:
Thus in this World, poor Lad did meet
  With Troubles manifold,
Sodom being burnt, he did retreat,
  And dwelt in a ſtrong Hold:
Laid in the Cave. Being drunk with Wine,
  Begot *Moab* and his Brother,
Of's Daughter, who as you define,
  Was Siſter and Grandmother.
Thus Grandmother and Mother too,
  Did bear *Moab* as a Son,
His Grandmother, *Lot's* Wife was dead,
  E'er *Moab's* Life begun;
She was transformed into Salt,
  The Scriptures plainly ſay,
Looking to *Sodom* was her Fault;
  She God did diſobey;
This Pillar fixed on the Earth,
  Joſephus doth relate,
Hundreds of Years after *Moab's* Birth
  He ſaw't in the ſame State.

66. *Chriſtians* the Week's firſt Day for *Sabbath* hold,
The *Jews* the ſeventh (as they did of old)
The *Turks* the ſixth (as I have oft been told)

Now, Good Sir, pray tell to me,
How it is poffible this Thing can be,
That ever a *Chriftian*, *Jew* and *Turk*, thefe three,
Being altogether, in one Place may,
In and upon one and the felf fame Day-
Have each his own true *Sabbath*, tell I pray.

Anfwer. From the Place of the *Jew's* Abode let the o-
  ther two fet out,   (bout;
The *Chriftian Eaft*. the *Turk Weft*. and fail the Globe a-
Then with the *Jew* they will agree when they again
  do meet,   (keep.
And all upon the *Saturday* will their true Sabbaths

67. Walking one Evening on the Sandy Shore,
Where Shell-Fifh breed, and Seas for ever roar,
I faw a Ship dance on the rolling Tide,
With curling Smoke advancing from her Side ;
Which for fome Moments my dull Senfe employs,
Before I heard the thund'ring Cannon's Noife.
Then from my Fob Time's Regifter I drew,
And from her Sides a fecond Light'ning flew ;
Till fourteen Seconds of fwift Time expir'd,
Before the Sound my lift'ning Ears admir'd.
Ye learned Heads, that Sound's Progreffion know,
My Diftance from the floating Veffel fhow.

Anfwer. The Diftance of the Ship from you was 3
Englifh Miles, 148 Feet, or 2 Miles *Irifh*, 2548 Feet, al-
lowing Sound to move 1142 Feet in a Second of Time.
Note, The Sound of a Bell. in the Receiver of an
Air-Pump, when the Air is exhaufted. is hardly heard ;
or a Gun on the Top of *Pico Teneriff*; but in an un-
haufted Receiver, a fmall Bell may be heard many
Places off, and the further the more the Air is compref-
fed. Thefe prove that Sound depends on the Vibrati-
ons of the fonorous Body on the Air.

But left I tire any with Verfe, I now return again
Now Profe.

68. There are three remarkable Places, on the *Terra-queous Globe*, to whofe Inhabitants all the Stars are vifible, on three certain Nights of the Year.

Anfwer. Under the Æquator; for at the firft Part of the Night you fee one Hemifphere, or half of the Stars, which in twelve Hours Time entirely fets againft Morning. when the other Half appears that was entirely hid the Evening before : Thus there are not only three remarkable Places, but all Places under or near the Æquator; the beft Time is when the Nights are longeft, if the Places be not directly under the Æquator.

69. There is a certain Place on the Earth, above whofe Horizon *Saturn* is fifteen Years; and there is another of a confiderable Diftance from that, which hath *Jupiter* above five Years without Setting above their *Horizon.*

Anfwer. This Place is under or near the *Poles*, where *Saturn* continues without Setting near fifteen Years; as *Saturn* entred *Aries* about the Middle of *March*, 1701, and paffed thro' the fix following Signs, entring *Libra* 20th of *September*, 1715. which amounts to near fifteen Years; during which Time it may be fuppofed, that *Saturn* was feen above the *Horizon* of the *North-Pole* : Alfo the other Place (mention'd in the Paradox) of a confiderable Diftance. is the *South-Pole*, where *Jupiter* might have been feen from *March* 1707, till *March* 1714.

70. It may be demonftrated by the *Globe*, that the *Sun. Moon*, and feveral of the Planets, do not move exactly fifteen Degrees hourly, from the *Meridian* of feveral Places on the *Continent* of *AMERICA.* but come later to their *Meridian*, than the preceding Day.

Anfwer. Either it may be fome floating Ifland; or this may arife from the diurnal Advance of the Sun, Moon and Planets in their particular Orbs, which exceed the fifteen Degrees hourly, or the three hundred and fixty Degrees of the Equinox by the faid diurnal Motion of the Planets,

71. There

71. *There is a certain Wall, in the City of* Dublin, *whose Situation is due* Eaft *and* Weft; *yet, 'tis certain, the* Sun *will fhine on the* North *Side thereof before fix in the Evening, all the* Summer, *and on the* South *Side before fix in the Morning.*

Anfwer. The Wall here meant. whofe Situation is due *Eaft* and *Weft*, the *North* Side is perpendicular, the Sun having *North* Declination all the *Summer*, will fhine on the *North* Side before fix in the Evening; and the *South* Side of that Wall hath a reclining Plane whofe Acclination is greater than the Latitude of the Place; then may the Sun fhine on that Plane before fix in the Morning all the *Summer*.

Or thus,

The Sun being a great Body and upon Motion; fome of it will pafs by the Wall before the Whole, and confequently fend fome of its Rays on the *North* Side before it be exactly fix o'Clock, which on the E-quinoctial Days is precifely when the Sun's Center is in a right Line, with the Wall, which is a confiderable Time after Part of it fhines on the *North* Side, *i. e.* fo long as the *North* Semidiameter of the Sun is tranfiting that Line of due *Eaft* and *Weft*.

72. *There are feveral remarkable* Places, *a-bove an hundred Miles afunder, which have no* Antæci; *and their* Periæci *are as far off them as their* Antipodes: *There are alfo two* Places, *above five hundred Miles afunder, which have no* Periæci, *and their* Antipodes *are as near them as their* Antæci.

Anfwer.

Anfwer. Thofe feveral Places an hundred Miles afun der, are all on the Æquator, which therefore hav no *Antæci* and the *Periæci* are diametrically oppofite and are alfo, confequently *Antipodes.* The other tw Places above five hundred Miles afunder, which hav no *Periæci*, are the two *Poles*, who are both *Antæci* and *Antipodes* to each other.

73. *'Tis certainly Matter of Fact, that three certain Travellers went a Journey, in which tho' their Heads travelled full twelve Yards more than their Feet, yet they all return'd alive with their Heads on.*

Anfwer. According to the Corollary of the laft Pro pofition of the third Book of *Whifton's Euclid.* If a one fhould travel over the whole Circumference of the Earth, t Way gone over by his Head would exceed that which was g over by his Feet, by the Difference of Circumferences; or by th Circumference of a Circle, whofe Semidiameter is the Man's ow Stature.

Now fuppofe *Drake, Cavendifh*, or *Dampier*, each o them to be two Yards, then will the Diameter be fou Yards, and the Circumference about twelve Yards whereas did they ride or go on the Top-maft, ther would be ftill a greater Difference in each of their Voy ages round the Globe.

74. *Though it be generally affirm'd, that th Arch of a great Circle, betwixt two Places, i their fhorteft Diftance; yet there are two Pla ces fo fituated, as their Diftance is confidera bly fhorter than the Arch of a great Circle yea, and there be feveral Places, betwixt whic 'tis their longeft Diftance.*

Anfwer

Anfwer. At the Bottom of the Ocean, fome deep Cave. Valley, Mine, or fome Places in the Earth, conſiderably below the Surface thereof ; and for the latter Part, it muſt intend the *Antipodes*, which is the longeſt or greateſt Diſtance poſſible.

75. *There are ſertain Places in* North *Latitude, whoſe longeſt Artificial Day, is conſiderably longer, by ſome Hours, than the longeſt Artificial Day with them in the ſame Degree of* South *Latitude.*

Anſwer. The *North Pole*, or near it, becauſe the Sun ſpends above eight Days more in the Artificial Day, under the *North Pole*, betwixt *Aries* and *Libra*, than in the Artificial Day under the *South Pole*, betwixt *Libra* and *Aries*.

76. *Any two Places, of a conſiderable Diſtance from each other, whoſe Bearing is truly known, and is not on one of the* Cardinal *Points ; yet if a Ship keep continually on the ſame Point, on which the Port bears off, tho' they duly rectify the* Compaſs, *and regard both Currents and Winds, it may be plainly demonſtrated by the* Globe, *that inſtead of hitting it, ſhe will be further and further off, and never will hit it on that Point.*

Anſwer. Such is the Difference between the Angle of Poſition and the Rumb by the Compaſs, that if the Ship ſteers by the Compaſs, on the ſame Point that the Port bears off, by the Circle of Poſition, it will never hit.

77. *There*

77. *There is a certain Place in* Great-Bri-
tain, where, when the Tide is in, one may fe
the Sheep feeding on a certain neighbouring I
fland; yet when the Tide is out, and the Wate
at loweft, not one can be feen, tho' they be feed
ing there at the fame Inftant.

Anfwer. The Place may be the Wharf of *Greenwich*
and the Ifland of *Dogs* over againft it, and the Appear-
ance caufed by the Refraction of Sight when the Wa-
ter is high. *See Paradox* 18.

78. *That no Colours are real, but what we*
call Red, Yellow, Green or Blue, &c. only ap-
pear fo to us, according as Bodies varioufly
receive their Light; and that there are no Co-
lours in the Dark.

Anfwer. Nothing is fo manifeft to the Senfe as Co-
lour, nothing fo obfcure to the Underftanding; which
doubts whether it has a real Exiftence, or whether it
only appears fuch to us, according as Bodies varioufly
receive the Light; for we judge of them otherwife in
the Twilight, in the Sun, and in the Shadow, otherwife
beholding them flopingly, directly, or thro' a colour'd
Glafs. Are any Colours fairer than thofe of the *Rainbow,*
and yet they are no more real than thofe of the Cloud:
The Whitenefs we behold in the Milky Way *arif-
eth only from the Light of many fmall Stars, Pictures
are apprehended well or ill drawn according to their
Situation: Nay, the vifible Species are nothing elfe
but Qualities ftreaming from every terminated Body,
which alter the Medium, filling the fame with their
Images, which they diffufe even into the Organ. Now
Colours are the fame, being Qualities which actually
change

hange and alter their diaphanous and illuminated
body: Or the Subſtance of Light it ſelf, differently
reflected from thoſe objected Bodies, as in the Caſe of
riſms, &c. And to explain this Paradox more fully,
extend a Yard of Scarlet Cloth, in an uniform Light,
then fold it, and view one half in the Sun-ſhine, the
other half in the reflected Light, and fold it in and
out, like the Paper Lanthorns of a Kite, all which di-
gently obſerve, as you move it thro' the various De-
rees of Light and Shade, and you will admire the
ſt Variety of Colours apparent thereon, none of
hich are more real and inherent one than the other,
nly a Diſpoſition to reflect the Varieties of Reds,
lively Carnation, Sanguine, Murry (or ſable Black
the dark Shade or Abſence of Light) and this Diſ-
oſition ariſes from the Cloth being ting'd in a cer-
in Liquor, whoſe minute Particles are, by reaſon
their Figure and Poſition, adapted to refract the
ncident Rays of Light after ſuch Modification, as to
reſent Red, rather than Green, Blue. &c. which re-
uires different Degrees of Refrangibility. *See* New-
on's *Optics.*

79. *No Man can ſee the ſame Particle of an
Object with both Eyes at once, nay not with the
ame Eye, if the Level of its viſive Axis be
changed.*

Anſwer. This Paradox ſeems confirm'd both by Ex-
erience and Reaſon. 1. Becauſe no Man can make
he Viſion of both his Eyes equally perfect; but be-
olding a Thing firſt with one Eye, the other being
oſed, ſhall conſtantly diſcover it to be greater in
imenſions, in the Apprehenſion of one Eye than of
he other. So *Gaſſendus,* Epiſt. 2. Sect. 17. teſtifies that
he Characters of his Book appear'd to his right Eye,
y one fifth Part, greater in Dimenſions, tho' ſome-
hat more obſcure, than to his Left. 2dly, Becauſe
of

of all twin Parts of the Body, one is always more pe
fect and vigorous than the other, which, if not t
Effect of Cuſtom, may proceed from a more libe
Afflux of Spirits to one than the other: Or the Org
nical Conſtitution may vary a little, as if one Pu
be wider, the Chriſtalline more Convex, &c. Su
like Cauſes neceſſitate a reſpective Diſparity in t
Action.

80. *The ſame Object ſpeculated by the ſam*
Man, at the ſame Diſtance, and in the ſam
Degree of Light, doth always appear great
to one Eye than the other; and that all Men
diſtinctly but with one Eye at once, contrary
that Axiom, That the viſive Axes of both E
concur and unite in the Object.

Anſwer. Notwithſtanding the Repugnancy of t
Paradox to common Opinion, yet its Verity ought
be aſſerted; for the Axes of the Eyes were ſo ordain
by Nature, that when one is intended the other
relaxed, nor can they be both employ'd at once, th
both at once may be relaxed, becauſe of the Paral
liſm of the Motion of the Eyes, which is evident
Senſe: Nor is there more Neceſſity to uſe both Ev
than both Arms or Legs at once; for Inſtance, lo
but at the Top of your own Noſe, and you will
ſoon convinc'd that you cannot diſcern it wi
both Eyes at once, but the right Side with the rig
Eye, and the left Side with the left Eye; for when t
Axe of the right Eye is converted to the right Side
the Noſe, the *Axe* of the Left muſt be converted t
wards the left Ear. For a further Illuſtration, in t
Chamber ſet up a Staff, retreat a few Feet, and
your Head againſt the Wall, then ſee what Pane
Glaſs, or Part thereof the Staff hides from the rig
Eye, when the left is ſhut; alſo, without movi

e Head, fhut the right Eye and open the Left, and
e what Part of the Pane is then hid, which will be
ry different from the former, and their Diftance a-
nder is called the Parallax of Sight; then open
oth Eyes. and view if the *Axes* of both did meet
d unite in the Staff, as is generally fuppofed, then,
f Neceffity, would you obferve the Staff to eclipfe
ther both Parts of the Window together, or the
iddle of the *Parallax*; but you fhall obferve it to do
either, but only one of the Parts, and that on which
ou fhall fix one of your Eyes more intently than the
ther : Hence we may with *Gaffendus*, affure the Gun-
ers that they fhall fhoot as right with both Eyes open
only with one : Thus in confus'd and imperfect
ifion; tho' it may be truly faid, a Man doth fee with
oth Eyes at once, but not diftinct and perfect, there
eing feveral Degrees of Vifion.

81. *That the Matter of a Body, when rare-d, doth poffefs no more of true Place than the Matter of the fame Body condenfed.*

Anfwer. When a Fleece of Wool is diftended, we
y 'tis made more rare, and when compreft more
enfe ; now the Rarefaction confifts in this, that the
airs formerly united are difunited, and the Spaces
twixt them become larger, in which no Particle of
ool is contain'd, and Denfity is quite the contrary ;
ow tho' a Fleece of Wool expanded includes a grea-
r Capacity therein than when compreft, yet the fin-
e Hairs thereof take no greater Space in either Ca-
city; for no Hair can poffefs more Space than its
oper Bulk requires, but the empty airy Spaces in-
rcepted, are enlarged in the Rarefaction and dimi-
fhed in the Compreffion: Hence 'tis true, that the
atter of a Body rarefy'd, *i. e.* the fundry indefinite
rticles poffefs no more of true or proper Place
an the Matter of the fame Body condenfed, though
e Surface of the fame Body may poffefs more Place,

F　　　　　　　when

when rarefied than when condenfed, becaufe then it
not only takes in the Particles of Space occupied by
the Particles of Matter rarefied, but alfo all the enlarg'd
Vacuities interfperfed.

*82. A certain Traveller, of unqueftionable
Integrity relates, he, in the* Eaft-Indies, *faw
Sun, Moon and Stars all at once, at Noon-
Day: Yea, and in the Reign of* Tiberius, *the
Sun was feen to fet at Noon, when it was
Full-Moon; and tho' there was Darknefs a-
bove the Earth, yet was there Light under it,
nay, that very Darknefs became a Light, and
in a few Days two real Suns, not mock ones a-
rofe in one Day, within a few Hours of each
other.*

Anfwer. This confifts of feveral Parts, as to the Firft,
Father *Kircher.* in his Defcription of the Subterrane-
ous World, *Lib.* 2. tells us, that by the Help of a Te-
lefcope we may perceive the Sun a Body of Fire une-
qual in its Surface, compos'd of feveral Parts of a dif-
ferent Nature; fome fluid, fome folid, and that his
Disk is a Sea of Fire, wherein one may perceive an
eternal Agitation of the Waves of Flame, that in
fome Parts of it there arifes a deal of Smoke: Now
'tis very probable, that a vaft Quantity of Smoke
might intercept and hinder the Brightnefs of the
Sun; as in 1547, from the 4th to the 28th of *Auguft,*
the Sun appear'd reddifh, and not fo bright as the
Moon in her total Eclipfe, fo that then there were
many Stars vifible at Noon-Day, which being as bright
as at other Times, plainly fhow, the fix'd Stars receive
not their Light from the Sun, but are rather fo many
Suns themfelves, at an indefinite Diftance.

As to the latter Part of the *Paradox*, becaufe the Reign of *Tiberius* is mentioned, probably that preternatural Darknefs which happen'd at our Saviour's Crucifixion. which was then Full-Moon, is meant, and the Darknefs began at Noon, or 6th *Jewifh* Hour, and continued to the 9th, which miraculous Darknefs alfo, proved a Light to *Dyonifius* the *Areopagite*, of whom it is reported, that beholding it, he faid, *Either the World is at an End, or the God of Nature fuffers*; and in a few Days, *i. e.* on the third Day early in the Morning, before Sun-rife. arofe the very *Sun of Righteoufnefs*, who was, and is. *The true Light that enlightens every Man coming into the World*; according to *John* 1. 9.

83. *There are feveral Places on the* Continent *of* EUROPE, *where, at fome certain Seafons of the Year, if a Feather and Globe of Lead, were let fall exactly together, the Feather will reach the Bottom as foon as the Lead; which Places, then, are of fuch a deteftable Quality, that if a* Sparrow, *never fo lively, fhould chance to fly over it, would immediately fall down in a Swoon, which upon breathing on, in the Turn of an Hand, will revive and be as brisk as ever.*

Anfwer: In any Place where the Air-Pump is, and at any Seafon when the Receiver is exhaufted of the Air within, fuch ftrange Effects will happen: and by *breathing upon, in the Turn of an Hand*, is intended the Re-admiffion of the Air, whereby the Sparrow will revive again.

F 2 84. On

84. *On the* Continent *of* A S I A, *there is a certain Country, some of whose Inhabitants, though they live not many Hours, yet they breed and bear without Food or Care, and their Generations have continued many Ages, where also the very Desart affords them vegetable Springs of Water.*

Answer. Navarette tells us of a Tree called the *Bejuco,* which twisting about other Trees, with its End hanging downwards, and that Travellers cut the Nib off it, and presently a Spout of Water runs out from it as clear as Chrystal. enough and to spare for six or eight Men. *I drank* (saith he) *to my Satisfaction of it, and found it cool and sweet, and would drink it as oft as I found it in my Way; it is a Juice and natural Water.* 'Tis the common Relief of the Herdsmen on the Mountains, when they are thirsty they lay hold on the Bejuco and drink their fill. Collect. of Voyag. Vol. 1. pag. 355. this then is a delectable vegetable Spring of Water. Also, if an Insect may be term'd an Inhabitant, *Swammerdam* mentions the *Ephemeron,* which is both an unusual and special Instance of the Brevity of Life, and a wonderful Instance of the special Care and Providence of *G O D* in the Conservation of the Species of that Animal: For, 1st, As an Animal, whose Life is determined in about five or six Hours, it needs no Food. 2d. As to its Generation, in those five Hours of its Life it performs that and other necessary Offices of Life; for in the Beginning of its Life it sheds its Coat, and that being done, and the poor little Animal thereby rendered light and agil, it spends the rest of its short Time in frisking over the Waters, and, at the same Time, the Female droppeth her Eggs on the Waters, and the Male his Sperm on them, to impregnate them these Eggs are spread about by the Waters, and descend to the Bottom by their own Gravity, and are hatch'd by
the

the Warmth of the Sun, into little Worms, which make themfelves Cafes of the Clay and feed on the fame, without any Need of Parental Care.

85. *'Tis as demonftrable as wonderful, that Mathematicians may draw Lines both ftrait and circular, which fhall always approach near-er and nearer to a given Line, even unto Infini-ty; but either will never be joyn'd to it, or if joyn'd will never unite or meet, fave in one fingle Point; and tho' the Angles formed at the faid Point may be diminifhed by Arches, yet cannot fo much as be bifected by any right Line whatever; and faid Angles are both greater, equal and lefs than a right Angle.*

Anfwer. The Corollaries of the 16th Propofition of the third Book of *Whifton's* Euclid aforefaid, will illuf-trate this *Paradox* to which I refer, when I have told my Reader that this *Paradox* means, not only the An-gle of Contact, but the Approach of the Afymptotes to an Hyperbola, both infinitely produced unto a Di-ftance, lefs than any given one, yet never concurring with it: By this Propofition, is plainly inferr'd the infinite Divifibility of Matter, Lines and Points.

86. *There is a certain Ifland in the* Conti-nent *of* EUROPE, *fome of whofe Inhabi-tants are of fuch exquifite Sight, that even with one of their Eyes, they can actually behold ten Moons real and true, all at once, above their* Horizon, *yea, and ten Times the Number of*

F 3   *Stars*

*Stars beheld by others with both their Eyes at
the fame Inftant, Yea, fuch wonderful Proper-
ties have thefe fingle-fighted few, that in Things
fmall and near, which efcape the Sight of their
Neighbours, they behold new Worlds of Wonder,
fee all the diftinct Parts and Functions of thofe
minute Animals : Nay, like Cats, they can fee
in the Dark, and in an Inftant, and in the
Dark alfo, draw, to the Life, and paint in
lively Colours, far beyond Michael Angelo, or
any other, in the beft Light and longeft Time.
Laftly, fuch dextrous Hands have they, that
in the Turn of an Hand they can command the
Sun, Moon and Planets to rife and fet and per-
form their diurnal Revolutions and their annu-
al ones in a few Minutes, and predict ther mu-
tual Eclipfes for many Years to come.*

Anfwer. Any Ifland, any where, provided there be
Mathematicians furnifh'd with exquifite Telefcopes,
which will fhow the five Satellites or Moons of *Sa-
turn*, the four Moons of *Jupiter*, and our Moon, all
which are ten in Number, fuch will fee through them
ten Stars for one beheld by our Eyes not affifted with
the like; nay, in the Milky-Way, where we can't be-
hold one, they will fee an innumerable Company fo
clofe and thick fet, that their united faint Light caufe
that Whitenefs which gives it the Denomination a-
forefaid. The middle Part of the *Paradox* refpects the
Wonders of the Microfcope, and the next intends
the admirable and Inftantaneous Painting to the Life,
perform'd by the *Obfcura Camera* (or dark Room) of the
Philofophers; and the *Laft* Means the noble and ufeful
Invention of the *Orrery*, which fhows, by one Turn
of the Hand, the vifible Revolution of the *Earth*,

Moon,

Moon, Venus and *Mercury,* their mutual Afpects, Eclipfes, &c. for any Time paft, prefent or to come.

The Periodical Revolution of the Moons of Saturn *and* Jupiter.

		D.	H.	M.	S.			D.	H.	M.	S.
1		1	21	18	31			1	18	28	00
2	next	2	17	41	27	next	3	13	14	00
3	Saturn.	4	13	47	16	Jupiter.	7	3	43	00
4		15	22	41	11			16	16	32	00
5		79	7	53	57						

87. *There is a certain Ifland in* EUROPE, *for which, in four or five certain Months of the Year, if the ableft Aftronomers the World has, would calculate the Moon's Rifing, they would not only differ in Minutes and Seconds, but whole Hours ; and from which if they take a Journey in one Part, their Shadows will difappear ; in another they will circuit all Parts of the* Compafs.

Anfwer. **This** may refpect the Variety of Rifings of the Planets and Stars, as to one the Cofmical, the other the Acronical, the third the Heliacal, the fourth the true or apparent Diurnal Rifing of the Moon : Each Aftronomer, tho' exactly true, refpecting that particular Rifing, will differ from the reft, not only in Minutes and Seconds, but Hours and Days: The latter Part of the *Paradox* refpects the Diverfity of Shadows; under the Poles or Polar Circles the Shadows move all round about, under the *Tropics* no Shadow at all, when the Sun is in the *Zenith*; but in the *North* Temperate, our Noon Shadow is always *North*; and in the *South* Temperate, always *South*.

88. **Tₒ**

88. *To feveral Parts of this Globe, there be certain Planets, which are fo far from coming to an Oppofition, that they form neither Trine, Square nor Sextile Afpect with the Sun. And there be other Places, where, if you bring a* Mariners Compafs, *though never fo well touched and rectified, the Needle is of no Service, becaufe it will turn indifferently, to any Point of the* Compafs, *tho' neither Iron nor Loadftone be near.*

Anfwer. Venus and *Mercury.* whofe Orbits are contain'd within the Orbits of the Earth, never form fo much as a Sextile Afpect with the Sun: And in or near the two *Poles* of the Earth, the beft Needle turns indifferently to any Point of the *Compafs.*

89. *There be feveral Planets or wandring Stars, which at certain Times, appear and difappear, whofe Light decreafes as they came towards the Earth, and increafes as they go from the Earth ; yea, fo tranfparent are they, that the fmalleft Stars may be feen through them: Yea, and there be others fo opake, that in Conjunction with the* Sun, *they appear as Spots in his Face, and the further they go from us the bigger they appear.*

Anfwer.

Anſwer. The firſt Part reſpects Comets, which wander through all the Orbits of the fixed Stars, and do decreaſe in Light as they come towards the Earth, and increaſe as they go from it; through whoſe Tails the fixed Stars of the 6th Magnitude may be ſeen: The other opake Planets, which appear as Spots now and then in the Sun's Face, are *Venus, Mercury,* and the *Moon* which appears bigger in the Horizon when further from us, than in the Meridian when ſhe is above three thouſand Miles nearer us, as in *Paradox* 19. The Cauſe of which *Phænomenon* ſome attribute to the Refraction, others to the Picture in the Bottom of the Eye, others to the Judgment in great Diſtances, ſays *Graveſand, Vol.* 2. *N.* 731. " If we look at known Objects we " judge from the apparent Magnitude and Colour " which depends upon the Bigneſs of the Picture in " the Bottom of the Eye, and this on the Angle un-" der which the Object is ſeen."

Now 'tis well known to Aſtronomers, the Picture of the Sun in the Bottom of the Eye, is the ſame in both Caſes, and that of the Moon is leſs when it appears near the Horizon, becauſe ſhe is farther off by a Semidiameter of the Earth, which bears ſome Proportion to her Diſtance from the Earth, though little with reſpect to the Sun's Diſtance from us, yet they appear greater near the Horizon by reaſon of the Interpoſition of the Fields and Houſes betwixt us and that Part of the Heavens: Alſo they appear nearer to us, and of a different Colour, becauſe of the Dimneſs, Groſneſs and Denſity of the lower Atmoſphere, the Body of the Air is twelve times greater near the Horizon than near the *Zenith,* thro' which the Rays of the Sun paſs; this not only magnifies the Refraction, but ſo dims its bright Rays, that without hurting the Eyes we can look upon him Riſing or Setting; but not ſo when on the Meridian near the Zenith; becauſe its Rays hitting againſt an infinite Number of Particles in the Air, near the Horizon are reflected or abſorb'd.

How-

Howbeit, if we fee the Bodies above mentioned thro' a Tube, this apparent Diſtance vaniſhes, as alſo the Magnitude which is deduced from it: From our Childhood upwards, and ſo continually, we join the Idea of Diſtance with the increaſe of apparent Magnitude, whereby the Ideas are ſo cloſely joined that they cannot be ſeparated; not even in thoſe Caſes in which we know they lead us into Error.

Moreover, Refraction cauſes the horizontal Sun and Moon to appear of an oval Figure; for their inferior Limbs are more refracted and raiſed higher than their ſuperior Limbs are; and therefore theſe two Limbs will ſeem nearer to each other, while the Ends of the horizontal Diameter being equally refracted keep the ſame Diſtance.

The *French* obſerved, that an Object which at Break of Day appeared in our Horizon or level Line, or a little above it, a little after Sun-Riſe, appear'd below it; and the ſame Appearance they found in the Evening; for the Object before Sun-Set appeared below the Level, which ſoon after Sun-Set would appear in it in ſo much that in about half an Hour's Time the Difference has been obſerved to be no leſs than three Minutes, the Cold of the Night condenſing the Vapours, making them of different Denſity, cauſes the Refraction aforeſaid. Nay, three Points which appear at one Time in a ſtrait Line, have at another Time, within half an Hour, appear'd out of it conſiderably. Hence, even the Sight it ſelf that is the Ray of Light, paſſing from Point to Point thro' the Air, is not a ſtrait Line, as to its Poſition, by Reaſon of the different Refraction which is in the Medium of the Air.

90. *There be many Places of the Earth, to whoſe Inhabitants the Sun and above twice ſeven Planets, may be all viſible in one certain*
Night

Night of the Year; and one of the said Pla-
nets, tho' it ever changes, yet still, to them,
turns always the same Face.

Answer. The five Moons of *Saturn*, the four Moons
of *Jupiter* and our Moon, which make ten Moons, be-
fides the ufual Planets *Venus* and *Mercury*, which are in-
ferior, and *Saturn Jupiter* and *Mars* which are the fupe-
rior Planets, befides the Earth. Howbeit all thefe
Moons are vifible only in thofe Places, where are ex-
traordinary Telefcopes, and only in thofe Nights
when they are out of the Shade of their primary Pla-
nets, about which they roll. 2*dly,* Our Moon, tho'
ever changing, as to our Phafes continually increa-
fing or decreafing in Light; yet becaufe her periodical
Revolution, about her Orbit and Axis, is perform'd
exactly in the fame Space of Time; therefore the
Moon's Axis keeps its Parallelifm, and ftill obverts the
fame Hemifphere or Face to the Earth, which as to its
Illumination and Obfcuration, is continually chang-
ing, according to its Recefs from and Accefs to the
Sun.

91. *There is a certain Fire which burns at a*
Diftance, and yet thofe that are feveral Yards
nearer and between, are not fo much as warm'd
by it ; nay, its Heat is greater the further it
is from us, and the lefs the nearer it is to
us.

Answer. This muft be the Sun which appears like a
burning Ocean, whofe Beams fcorch and burn near the
Earth, at the Foot of a Mountain; yet on the Top
Pico Teneriff, which is many Yards nearer to it, the
Sun's

Sun's Reflection fcarce reaches or warms; where the cold Air continually changes for frefh. Moreover, the Sun's Heat, every Body knows, is greateft in *Summer* when he is furtheft from us, and leaft in *Winter* when he is neareft to us; for the Degrees of Heat and Cold do not altogether depend upon our Diftance from the Sun, the Difference of which Diftance is but fmall, and bears little Proportion to the Sun's Diftance from us; but there are other powerful concurring Caufes which have certain Effects. For firft of all, the direct Force of the Sun's Rays, is much ftronger than when they are receiv'd obliquely; becaufe there are much fewer Rays in the fame Space, when the Rays fall obliquely than direct: Befides in *Winter* when the Sun is neareft to us, as aforefaid, his Rays or Beams pafs thro' a much greater Quantity of Air, and are deeper immers'd in our Atmofphere than they are in *Summer* when the Sun is furtheft off us. Again, in *Summer* we have fixteen Hours Sun-fhine, and but eight Hours Night, but in the *Winter* the quite contrary; therefore no Wonder that the longer any hard Body is expofed to the Fire the hotter it ftill grows; for the Action of the Sun by which all Bodies are heated, is not tranfient, as its Illumination is, but permanent: For this Caufe, 'tis hotter under the Tropics, than the Æquator it felf, becaufe the Days are longer by an Hour and half there, than under the Line, from whofe Zenith the Sun recedes three Degrees in three Weeks Time; but is about two or three Months going fo far from the Zenith under the Tropics.

92. *There is one certain Place of the World where the Planets, both Inferior and Superior, may be beheld conftantly to move forward, in the fame regular and uniform Tenor; tho' in moft Places of the Earth they appear at the*

fame

fame Time to be ftationary, Retrograde, or to move very unequally.

Anfwer. At the Sun, the true Center of the World's Syftem, the Planets move all regular and direct ; tho' to us, out of the Center of their Orbits, they appear fometimes Direct, fometimes Retrograde, and fometimes Stationary.

93. *Of all the Stars in a Star-light Night, tho' their Number feems near infinite, and* FLAMSTEAD *has given a Catalogue of three thoufand, yet it will be hard for a piercing Eye to reckon, at any Time above an hundred ; notwithftanding in a clear Winter's Night, without Moon-fhine, at firft View they feem to be innumerable.*

Anfwer. This Appearance is only a Deception of our Sight, arifing from their vehement and ftrong Twinkling, while we look upon them confufedly and without reducing them to any Order; yet that in Reality their Number is next to infinite, appears from the Difcoveries the Telefcope has made; for Dr. *Hook*, with only his twelve Foot Telefcope, numbers feventy eight Stars in the Compafs of the *Pleiades*, where only fix appear to the naked Eye; and *Anton. Maria de Reita*, affirms. he has numbred, in the fingle Conftellation of *ORION*, two thoufand.

94. *Notwithftanding the diurnal Motion of the Earth about its Axis, and the annual*

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Answer. At the Sun, the true Center of the World's System, the Planets move all regular and direct ; tho' to us, out of the Center of their Orbits, they appear fometimes Direct, fometimes Retrograde, and fometimes Stationary.

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94. *Notwithftanding the diurnal Motion of the Earth about its Axis, and the annual*

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Mo-

Motion of the same about its Orbit, yet have sundry Astronomers attributed a third Motion to the Earth, i. e. *that whereby the Parallelism of its Axis is maintain'd; which others affirm is no Motion.*

Answer. The Parallelism of the Earth, or that constant Position of the Earth's *Axis,* which in every Point of its Orbit, is parallel to it self in any other Point; which never changes its Direction, but always looks to the same Point of the Heavens, doth necessarily follow; if the Earth hath no other Motion but that round the Sun, and the other round its own *Axis.* For tho' all the Diameters of the Earth will constantly change their Position by this Rotation about its *Axis,* except the *Axis* alone, which will remain at Rest (like the Center in a Circle) in its former State, the Points in the *Axis* being the only Points in that Body which have no Rotation,

95. *There are several Planets said to be in Conjunction with the Sun, not only when they appear in the same Degree of their Orbit with the Sun, but when they are in that Degree of their Orbit diametrically opposite to the former.*

Answer. The several Planets are *Venus* and *Mercury,* who have a two-fold Conjunction with the Sun, both in the superior and inferior or opposite Points of their Orbits; in the first they are like Spots between the Sun and us, and in the last the Sun is between us and them.

96. *There*

96. *There are fundry Places of the World, when coldeft, much hotter than any Part of the Torrid Zone, and yet no burning Mountain; and other Places, when hotteft, much colder than our* Frigid Zone.

Anfwer. The firft muft be in *Venus* or *Mercury*, and the laft muft be in *Saturn* or *Jupiter.*

97. *What Seas have their Waters frefh, and no Tide; neither ebbs nor flows? And what Streights and Springs have their Waters falt? and the Reafons why.*

Anfwer. The *Dead Sea*, the *Euxine* and *Baltic Seas* have frefh Water and no Tide; and the Streights of *Davis, Hudfon* and *Frobifher* are falt, becaufe the *Baltic Sea* has many Iflands at the Mouth of it; that it takes not in that Quantity of Water from the main Ocean, but receives more from the many frefh-Water Rivers which difcharge themfelves into it from *POLAND, RUSSIA* and *SWEDEN*; the like concerning the *Euxine.* And in *Burgundy* and *Lorain* there are Springs which fend forth falt Water; becaufe they diffolve the Salt which they meet with in the Earth as they run along.

98. *What is the Reafon of the Cohæfion of two well polifh'd Glaffes or Marbles together fo hard that three Quarters of an Hundred Weight, faftned to the lower, will not feparate it from the upper one.*

G 2　　　　　　　　　　*Anfwer*

Anfwer. Doubtlefs the Preffure of the Atmofphere, which preffed hard upon the obverted Planes of the Glafs or Marble; and there being no Air between, to refift the external Preffure, there muft neceffarily follow the Cohæfion aforefaid: For in an exhaufted Receiver one Pound Weight fufficed to part two fuch Marbles, that no lefs than eighty Pound Weight, in an open Air could feparate This Experiment of the famous *BOYL*, confirms the Preffure of the Atmofphere, and the above Solution.

99. *'Tis reported by the Duke of* Genoa, *that a Ship was found in* Switzerland *with the Bodies of forty Men in it : Alfo another Ship, in the Bottom of a Lake in* Italy, *which laft was fuppofed to be ever fince the Reign of* Tiberius: *How got they there ?*

Anfwer. That the firft could not be from *Noah's* Time, becaufe Navigation, efpecially on the Ocean, was not grown to fuch a Perfection in his Time as to make Ships of that Bignefs, and Anchors of that Perfection. 2*dly*, If fuch Ships had been, it might probably happen that fome other Men or Creatures might have efcaped with Life, befides thofe in the Ark. 3*dly*, How could a Ship of that Bignefs, be carried fix hundred Feet under Ground ? certainly twelve Months, much lefs forty Days Rain, could not reduce the Land to fuch a Quagmire.

Next, A fubterraneous Navigation feems a ridiculous Suppofition; wherefore for affigning a Caufe fufficient, I conceive, there cannot be a more probable one than the Effects of Earthquakes. Suppofe then that Part of *Switzerland* was the Bottom of the Sea, when this Veffel was directly over this Place, and an Earthquake happen'd juft underneath, which did raife the fame above the Level of the Water as much as 'tis now,

now, and clofing the Gap, inclofed both Water, Ship, and Men, which it had fwallowed.

100. *That there is another more powerful Caufe of the Twilight than the Reflexion of the Earth's Atmofphere.*

Anfwer. There is an Æthereal Air or Atmofphere round about the Sun, which fhines after the Suns Body is fet, this Orb of the Sun's Atmofphere rifing fooner and fetting later than the Sun it felf, fhines out at Mornings and Nights in a circular Figure, it being a Segment of the Sun's Atmofphere, cut by the Horizon, and its Light is quite of another Sort than that which is made by the Reflexion of our Atmofphere, but its Duration is much fhorter.

P. *Nonnius* to find the Length of the Twilight, watch'd the Time after Sun-Set, when the Twilight in the *Weft* was fhut in, fo that no more Light appear'd there, than in any other Part of the Sky near the Horizon: Then, by one of the known fixed Stars having taken the true Hour of the Night, found, by feveral Nights Obfervation, that at the Time of fhuting in the Twilight, the Sun was under the Horizon eighteen Degrees; and until the Sun was deprefs'd fo low, the Twilight continued.

The Sun being in the *Winter* Tropic maketh the longeft Twilight, and from thence, as the Days increafe, the Twilight decreafes until it comes to the fhorteft, which is in a certain Parallel between the Tropic and Equinoctial, the Declination whereof is found by this Proportion: As Co-tangent of the Latitude to the Sine of the Latitude, fo is the Tangent of nine Degrees to the Sine of the Declination of the faid Parallel. But before the Crepufculum or Twilight comes to be the fhorteft, there is another

Paral-

Parallel, in which the Crepuſculum is equal to the Crepuſculum of the Equinoctial, which is found by this Proportion: As Radius to the Sine of the Latitude. ſo is the Sine of eighteen Degrees to the Sine of the Declination of the Parallel ſought.

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PART

PART III.

AN
APPENDIX.

Containing ANSWERS to the Hundred *Arithmetical Problems* left unanfwered in *HILL's Arithmetick*, and *ALEXNDER's Algebra*..

I. TO find a Number which being multiply'd by 3, fubtracting 5 from the Product, and the Remainder divided by 2, if the Number fought be added to the Quotient, that the Sum may be 40.

Anfwer. The Number is 17.

2, To

2. To find a Number, which being multiplied by 12, and 48 added to the Product, as much may be produced, as if the same Number sought were multiplied by 18.

Answer. The Number is 18.

3. To find a Number, to which if 11 be added and 7 subtracted from the same Number (viz. the first) the Sum of the Addition may be double the Remainder.

Answer. The Number is $= 25$.

4. To find a Number, to which if its double (triple, quadruple, &c.) be added, the Square of the same Number may be produced.

Answer. Let $b =$ multiple, then the Number $= b + 1$.

5. To find a Number, which if added to it self, and the Sum multiplied by the same; and the same Number still subtracted from the Product: And lastly, the Remainder divided by the same, that it may produce 13.

Answer. The Number is 7.

6. To divide the Number 16 into 2 Parts, so that the Square of the greater Part may exceed the Square of the less by 32.

Answer. The Numbers are 9 and 7.

7. T

7. To divide the Number 36 into 2 Parts, so that if 12 be added to the first, and 6 to the second, the former may be the Double of the latter.

Answer. The Numbers are 24 and 12.

8. Let the Line AB (of 70 Parts) be divided any how in C (so that AC may be 42, BC 28) it is required to divide the same Line again in another Point : For Example, in D, so that the Rectangle ADC may be equal to the Square DB. Let the Segment CD be enquir'd (which being obtain'd, AD, DB will be known.)

A————————————C——¦————————B
　　　　　42　　　　　　　　28
　　　　　　　　　　　　　　　D
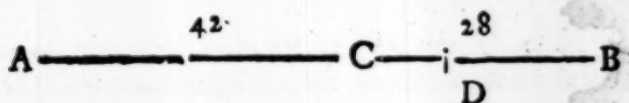
Answer. The Segment CD requir'd is = to 8.

9. Let the Line EF be divided any how in (so that EG may be 6, GF 4) it is required to produce this right Line EF (for Example into H) so that the Rectangle EHF may be equal to the Square GH; the Length of FH is required.

————————————¦——¦————————
　　　　6　　　　　　4
E　　　　　　G　　　　F　　　　H
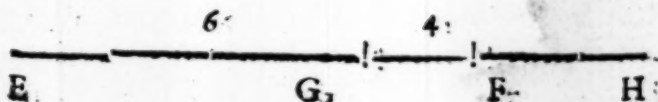
Answer.

Answer. The Length of F H sought is = to 8.

10. *A General disposing his Army into* Square Battle, *finds he has* 284 *Soldiers over and above; but increasing each Side with on Soldier, he wants* 25 *Soldiers to fill up th Square: How many Soldiers had he?*

Answer He had 24000.

11. *A certain Captain sends out* ⅓ *of hi Soldiers* + 10; *there remains* ½ + 15. *Ho many Soldiers had he?*

Answer. He had 150.

12. *There is an Army to which if you ad* ½, ⅔ *and* ¾, *of it self, and take away* 5000 *the Sum total will be* 100000. *What wa the Number of the Army?*

Answer. The Number was 36000.

13. *In the Rectangle A* B C D, *the Diff rence of the greater Side AB, and of the less Side B C is* 12; *but the Difference of th Squares of the Sides is* 1680. *What are the Side of the Rectangle ABCD?*

A ┌─────────────────────┐ B

D └─────────────────────┘ C
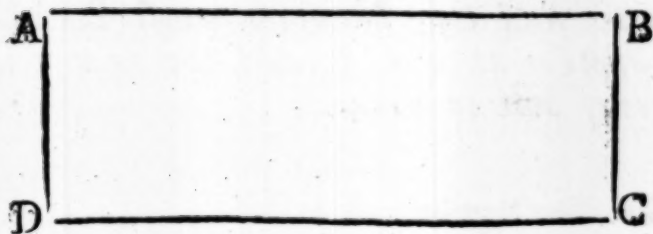
An,wer. Length = 76, and Breadth = 64.

14. *The Length* D E *of the Rectangle* DEFG, *is twice the Breadth* EF; *and the Sum of the Squares of the Length and Breadth is ten times the Sum of the two Sides* DE, EF. *What are the Sides of the Rectangle* DEFG.

D ┌─────────────────────┐ E

G └─────────────────────┘ F
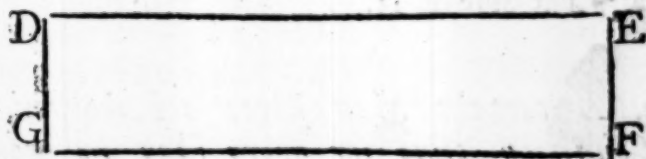
Anſwer. The Sides 6 and 12.

15. *To find two Numbers in the Proportion of* 2 *to* 3, *whoſe Product if they be multiplied by one another ſhall be* 54.

Anſwer. The Numbers are 9 and 6.

16. *To*

16. *To find two Numbers whose* Ratio is *to one another as* 4 *to* 5; *and the Sum of the Squares of both is* 2624.

Answer. The Numbers are 40 and 32.

17. *To find the Side of a Square, whose Area is to the sum of the sides in a given* Ratio, as 45 *to* 12.

Answer. The Side is 15.

18. *To find the side of a Cube, whose Super-ficies is to the Solidity in a given* Ratio, as 6 *to* 11.

Answer, The Side is 11.

19. *A certain Man hires a Labourer, on this Condition, that for every Day he work'd he should receive* 12 *Pence, but for every Day he was idle he should be mulct'd* 8 *Pence. When* 390 *Days were past, neither of them were indebted to the other. How many Days did he work, and how many was he idle?*

Answer. He wrought 156 Days, and was idle 234.

20. *A certain Gentleman hires a Servant, and promises him* 24 *Pounds yearly Wages,* to-

gether with a Cloak. At 8 *Months End the Servant obtains Leave to go away, and instead of his Wages receives a Cloak +* 13 *Pounds. How much did the Cloak cost ?*

Answer. It cost nine Pounds.

21. *A Person being ask'd how old he was, answered, If I quadruple ⅔ of my Years, and add ½ of them +* 50 *to the Product; the Sum will be so much above* 100, *as the Number of my Years is now below* 100.

Answer. His Age was 36 Years.

22. *One being ask'd what Hour of the Day it was, answer'd, The Day at this Time is* 16 *Hours long; if now ½ of the Hours past be added to ⅔ of the Remainder, you will have the Hour desired, reckoning from Sun-Rising.*

Answer. The Time from Sun-Rising is 9 ⅓ and consequently the Time of Day was 1 ⅓.

23. *From* Norimberg *to* Rome *are* 140 *Miles : A Traveller sets out at the same Time from each of the two Cities, one goes* 8 *Miles a Day, the other* 6. *In how many Days from their first setting out will they meet one another, and how many Miles did each of them go ?*

Answer. They'll meet in 10 Days, when the one has gone 80 and the other 60.

H   24. *A*

24. *A certain Messenger goes* 6 *Miles every Day:* 8 *Days after, another follows him, and he goes* 10 *Miles a Day. In what Number of Days will he come up to the first.*

Answer. In 12 Days.

25. *A certain Messenger goes* 6 *Miles a Day; and after he has gone* 56 *Miles, another follows him, who goes* 8 *Miles a Day. In how many Days will he come up to him?*

Answer. In 28 Days.

26. *One bought* 3 *Books, whose Prices were in Proportion as* 12, 5, 1 *: If the Price of the first be doubled, of the second tripled, of the third quadrupled; the Sum of these Products will as much exceed* 10 *Crowns, as the Sum of the Prices of the greatest and middle is below* 5. *How much did the said Books cost?*

Answer. The First cost 3, the Second $1\frac{1}{4}$, and the Third $\frac{1}{4}$.

27. *Suppose the Number* 50 *were to be divided into two Parts, so that the greater Part being divided by* 7, *and the less multiply'd by* 3, *the Sum of this Product and the former Quotient, may make the same Number proposed, which was* 50.

Answer.

Answer. The Parts are 35 and 15.

28. *Let the Number* 20 *be divided into two Parts, so that the square of the less Part being taken out of the square of the greater, may leave the very Number proposed, which was* 20 *(or may leave the double, triple, &c. of the Number propos'd.)*

Answer. The Parts are 10.5 and 9.5.

29. *If a Man gains* 30 *Crowns a Week, how much must he spend a Week to have* 500 *Crowns, together with the Expence of* 4 *Weeks remaining at the Year's End?*

Answer. 18.92857.

30. *A Labourer, after* 40 *Weeks in which he had been at Work, lays up* 28 *Crowns—the Pay of three Weeks; and finds that he had expended* 36 *Crowns* + *the Pay of eleven Weeks. What Pay did he receive a Week?*

Answer. He received two Crowns *per* Week.

31. *In the Rectangled-Triangle* ABC, *is given the Base* AB = 9 *and the Difference of the other sides, that is the Segment* BD = 3. *Required the sides* AC, BC.

Answer

C

D

A   9   B
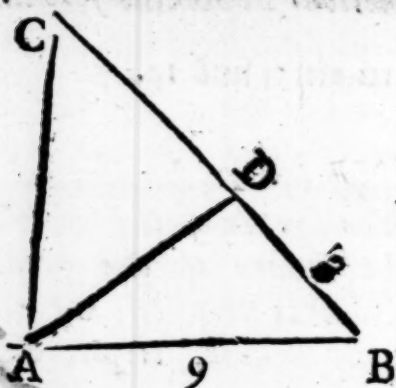
Answer. The Sides are 12 and 15.

32. In the *Rectangled-Triangle ABC*, is given the Base $AB = 5$, and the Sum of the other Sides $AC + BC = 25$. Required the Sides AC, BC *severally.*

B

25

C

A   5   B

Anſwer. The Sides are 13 and 12.

33. *Suppoſe two Towers, A*B 180 *Feet high, and C*D 240, *at the Diſtance A*C 360 *Feet. A Ladder is to be ſet upon the Line A*C, *at ſome Point, ſuppoſe in* E, *of ſuch a Length, as from thence it may reach the Top of both the Towers. We require the Point* E *in the Line of Diſtance, as alſo the Length of the Ladder* EB, ED.
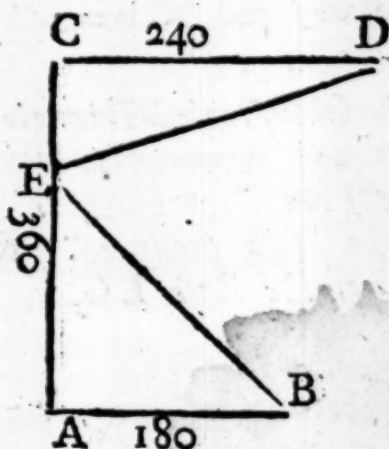
Anſwer. CE is = 145, AE is = 215, BE=DE= 280.44.

34. *In the Triangle ABC, the ſeveral Sides A*B = 13, *A*C = 14, B*C* = 15 *are given; and the Perpendicular B*D *being drawn. Required the Segment of the Baſe A*D, D*C.*

H 3　　　　　　　　*Anſwer*

B

13

15

A D 14 C
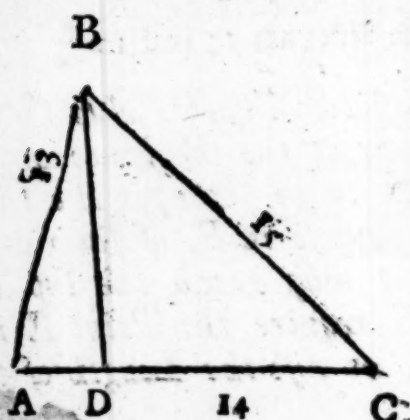
Answer. AD is = 5, and DC is = 9.

35. In the Obtufangled-Triangle DEF, that feveral fides are given, viz. DE 11; EF 13, DF 20; and the Perpendicular FG being let fall upon the Bafe produced. Required the Prolongation of the Bafe EG.

E

20

13

D 11 E G

Anfwer. EG is = 5.

36.
Differ
gonal
Differ
Diago
Sides

Anfw

Anfw

36. In the Rectangle *ABCD*, is given the Difference between the Length AB and the Diagonal BD; that is, DE = 2; and likewise the Difference between the Breadth *AD* and the Diagonal BD, that is FB, = 9. Required the Sides of the Rectangle *AB*, *AD*?

Answer. AB is = 15, and AD is = 8.

37. In a Rectangle *DEFG*, the right Line DK is drawn from the Angle D to the opposite Side, cutting the Diagonal EG at right Angles in H: And there is given the Segment HK = 2, and HE = 16. Required the Sides of the Rectangle?
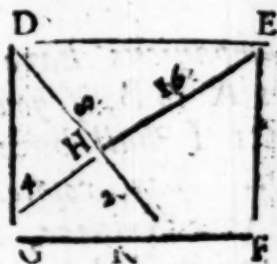
Answer. DE is = 17.888, and GD is = 8.944.

38. Let

38. Let there be a Circle, whose Diameter
A B, with another *less* Circle whose Diamet[er]
which is *AC,* touches within in *A:* And fro[m]
the Center of the greater Circle D, draw t[he]
Radius DE at right Angles to *AB,* cutting t[he]
Periphery of the *lesser* Circle in F.   Now the[re]
is given BC *(the* Difference of the Diameter[s]
= 9, with the Segment EF = 5.   Required t[he]
Diameters. *AB, AC of the said* Circles ?
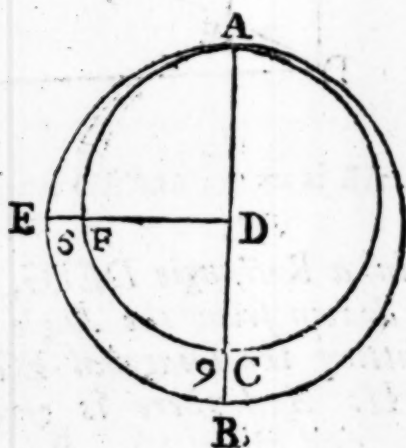
Answer. AB is = 50 and AC is = 41.

39. *Two Companions* have got a *Parcel*
Guineas ; *says* A *to* B, *if you will give me o[ne]*
of your *Guineas* I *shall have* as many as y[ou]
will have left.   Nay, replies B, if you w[ill]
give me one of your *Guineas,* I *shall have* tw[ice]
as many as you will have left.   How ma[ny]
Guineas had each of them?

Anſwer. A had 5, and B 7.

40. *A certain* Perſon *bought two* Horſes, *with the* Trappings, *which coſt* 100 Pounds; *which* Trappings *if laid on the firſt Horſe* A, *both the Horſes will be of equal Value: But if the ſaid* Trappings *be laid on the other Horſe, he will be double the Value of the firſt. How much did the ſaid Horſes coſt.*

Anſwer. The firſt coſt 200, and the ſecond 300.

41. *A* Vintner *has two ſorts of* Wine, *viz.* A *and* B; *which if mix'd in equal Parts, a* Flaggon *of mix'd will coſt* 15 Pence; *but if they be mix'd in a* ſeſqui-alter Proportion, *as if you ſhould take* 2 Flagons *of* A *as often as you take* 3 *of* B, *a* Flaggon *will coſt* 14 Pence. *Required the Price of each* Wine *ſingly?*

Anſwer. A Flaggon of A is worth 20 *d.* and of B 10 *d.*

42. *A* Son *asked his Father how old he was; his Father anſwered him thus. If you take away* 5 *from my Years, and divide the Remainder by* 8, *the* Quotient *will be* ½ *of your Age: But if you add* 2 *to your Age, and multiply the whole by* 3, *and then ſubtract* 7 *from the Product, you will have the Number of the Years of my*

my Age. What was the Age of the Fath
and the Son.

Anſwer. The Father 53, and the Son 18.

43. *To find out two Numbers, to the S*
whereof if you add 6, the whole ſhall be do
ble the greater; and if you ſubtract 2 fro
their Difference, the Remainder will be h
of the leaſt.

Anſwer. The Numbers are 14 and 8.

44. *To find two Numbers, the Prod*
whereof is 240, and the Triple of the great
divided by the leſs is 5.

Anſwer. The Numbers are 20 and 12.

45. *Two Men have a Mind to purchaſe*
Houſe rated at 1200 Pounds; ſays A to B,
you give me ⅔ *of your Money, I can purcha*
the Houſe alone; but ſays B to A if you w
give me ¼ *of yours, I ſhall be able to purcha*
the Houſe. How much Money had each
them?

Anſwer. A had 800 *l.* and B 600 *l.*

46 *Some young Men and Maids had*
Reckoning of 37 Crowns to pay for a Tre
and this was their Conditions, that ev
you

ung *Man should pay* 3 *Crowns, and every*
Maid 2. *Now if there had been as many*
ung Men as there were Maids obferving the
me Conditions, the Reckoning would have
me to 4 *Crowns lefs than it did. How many*
ung Men and Maids were there?

Anfwer. There were 7 $\frac{14}{23}$ Men, and 6 $\frac{2}{13}$ Maids.

47. *A General who had fought a Battle, up-*
n reviewing his Army, whofe Foot was thrice
he Number of his Horfe, finds that before the
Battle $\frac{2}{12}$ —— 120 *of his Foot had deferted,*
nd of his Horfe $\frac{1}{20}$ + 120, *befides* $\frac{1}{4}$ *of his*
hole Army were fent into Garrifons (reckoning
he fick and wounded) and $\frac{3}{8}$ *of his Army re-*
ain'd; the reft, who were wanting, being ei-
her flain or taken Prifoners; now if you add
ooo to the Number of the flain, the Sum will
e equal to half the Foot he had at the Begin-
ing. What were the Numbers of each?

Anfwer. 30,000 Foot, and 10,000 Horfe.

48. *To divide* 100 *twice into two Parts, fo*
hat the major *Part of the firft Divifion may*
e triple the minor *Part of the fecond Divi-*
fion; and the major *Part of the fecond may be*
double the minor *Part of the firft.*

Anfwer. The Parts are 60, 40, and 80, 20.

49. To *divide* 30 *twice into two Parts,* ſo that the major *Part of the firſt Diviſion, with* the minor *of the ſecond may be* 33; *and the* Sum *of the* minor *Parts ſubtracted from the* Sum *of the* major, *may leave* 14 *remaining.*

Anſwer. The Parts are 20, 10, and 17, 13.

50. *A Man,* his *Wife, and his Son's Ages* make up 96 *Years,* ſo that the Husband's and Son's *Years together make the Wife's* + 15; *but the* Wife's *and the* Son's *make the Husband's* + 2. *What was the Age of each?*

Anſwer. The Husband 47 Years, the Wife 40 $\frac{1}{2}$ and the Son 8 $\frac{1}{2}$.

51. *Three Merchants from three different Fairs met together at an Inn, where they reckon up their Gains, and find them the Sum of* 780 Crowns. *Moreover, if you add the Gain of the firſt and ſecond, and ſubtract the Gain of the third from the Sum, there remains the* Gain *of the firſt* + 82 Crowns; *but if you add the Gain of the ſecond and third, and from the Sum ſubtract the Gain of the firſt, there remains the* Gain *of the third* — 43 Crowns. *What was the Gain of each?*

Anſwer. The Gains were 316, 273, and 191 Crowns.

52. Three

52. *Three Persons,* A, B, C, *owe a certain Sum of Money, so that* A *and* B *together owe* 210 *Crowns;* B *and* C 290, *and* A *and* C 400. *What did each of them owe?*

Answer. A owed 160. B 50, and C 240.

53. *To find three Numbers, so that the first and half of the Remainder, the second and* ⅓ *of the Remainder, and the third and* ¼ *of the Remainder, may always make* 34.

Answer. The Numbers are 10, 12, and 16.

54. *Let a Square be divided into* 9 *small Squares: We are to find and dispose the* 9 *Digits through the several small Areas, so that the Sum of every three, taken either laterally or diagonally may be always* 15.

2	9	4
7	5	3
6	1	8

Answer.

55. *(Theorem) Let any Numbers whatsoever be given, if you subtract every less Number from that which is the next greatest: I say, that the Sum of those Differences is equal to the Difference of the greatest and least Numbers.*

I

56. *To*

56. *To find a Number, which being multiplied by 6, and the Product subtracted from the Square of the Number to be found, the Remainder will be* 280.

Answer. The Number is 20.

57. *To find a Number, which being multiplied by* 8, *and the Product added to the Square of the Number to be found, the Sum will be* 660.

Answer. The Number is 22.

58. *To divide* 140 *into two Parts, so that the Product of those Parts may equal the Square of* 56, *that is* 3136.

The Parts are 112 and 28.

59. *Let* 969 *Soldiers be drawn up into an oblong Battle, so that the Difference of the greater and less Sides is* 40. *Required the Number of the Soldiers in each Rank, in Length and Breadth.*

Answer. The Sides are 57 and 17.

60. *Again, Let* 480 *Soldiers be drawn up into an oblong Battle, so that the Sum of the greater and less Sides is* 52. *Required the*

Num-

Number of the Soldiers of each Rank in Length and Breadth?

Answer. The Sides are 40 and 12.

61. In the Square ABCD, is given the Difference of the Diagonal and the Side, that is EC = 6. *Required the Side of the Square?*

Answer. The Side is 14.481.

62. The Rectangle EK is added to the Square DF *(being of the same Height)* whose Breadth EL is given = 2, and also the Area of the whole compound Rectangle DK, = 60 *Required the Side of the Square?*

I 2   *Answer*

D   E 2 L

60

C   F   K
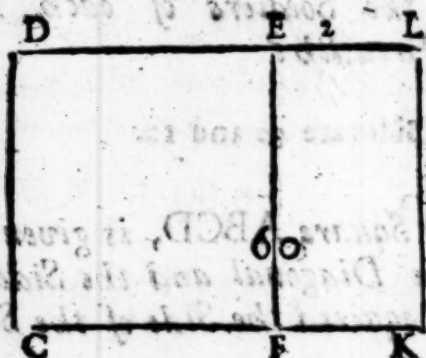
Answer. The Side is 6 : 81.

63. *A Man buys some Ells of Cloth for 70
Crowns ; and finds that if he had 4 Ells more,
he had then bought every Ell 2 Crowns cheaper.
How many Ells did he buy ?*

Answer. He bought 10 Ells.

64. *A Set of boon Companions dining at an
Inn, the Reckoning in all came to 175 Shil-
lings : But before the Bill was paid off, two of
them slunk away, and then the Club of those
that remain'd came to 10 Shillings a Man more,
How many were there in Company ?*

Answer. There were 7.

65. *To divide the Number 21 into two parts,
so that if the greater be divided by the less ;*
and

and again the *less* by the greater and then the *first* Quotient being multiply'd by 4, and the latter by 25, the *Numbers* produced may be equal.

Answer. The Parts are 15 and 6.

66. *Let the Line* A B *be divided in* C, *so that* A C *may be* 8, *and* C D 6: *We are to divide the same* A B *in* D, *so that the Rectangle under* A D *and* D C *may be equal to the Rectangle under* A C *and* C B, *or to the Product from* 8 *and* 6, *which is* 48. *Required the Segment* C D?

$$\begin{array}{ccc} 8 & & 6 \end{array}$$

A ———————— C —4— D B
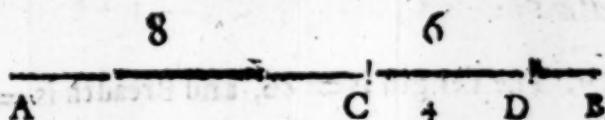
Answer. The Segment CD is = 4.

67. *Let there be a Rectangular Garden,* ABCD, *the Length of which* AB *is thrice the Breadth* AD; *and reckoning* 18 *Perches from* B *towards* A, *that is* BE, *and reckoning* EF *parallel to* AD, *let the Area of the remaining Rectangle* ED *be given* = 120 *square Perches. What was the Length and Breadth of the said Garden?*
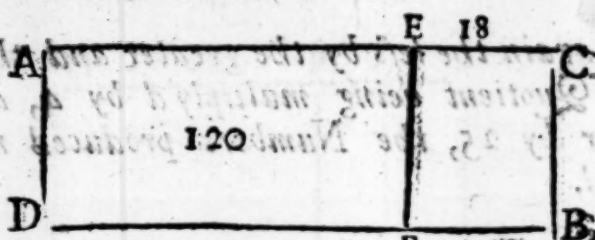
I 3 *Answer.*

Answer. The Length is = 30, and Breadth is = 10.

68. *Let* 600 *Soldiers be disposed into an ob-*
long Battle : Which the Colonel willing to make
broader, finds that if he takes away 10 *Ranks*
from the Length, he shall augment the Breadth
with two Ranks. What was the Number of
his Soldiers through every Rank in Length and
Breadth ?

Answer. The Length is = 60, and Breadth is = 10.

69. *A Man buys a Horse, which he sells a-*
gain for 56 *Crowns, and gains as many Crowns*
in 100 *as the Horse cost him. How much did*
he give for the Horse ?

Answer. He gave 40 Crowns.

70. *A certain Linen-Draper buys two sorts*
of Linen for 30 *Crowns, one finer, the other*
coarser : An Ell of the finest cost as many
Crowns as he had Ells : And also 28 *Ells of*
the coarsest at such a Price, that 8 *Ells cost as*
                                        many

many *Crowns as one Ell, of the finest.* How *many Ells of the finest Linen did he buy, and what Price did he give for them both?*

Answer. 4 Ells of the finest, at 4 Crowns *per* Ell, the coarsest cost half a Crown *per* Ell.

71. *In a certain rectangular Garden, the Length of which* AB, *is* 22 *Perches, and the Breadth* AD *is* 10, *the Walk* DG *is to be made, in a Situation parallel to the Sides of the Figure, so that the Area of the said Walk or Gnomon* DG *may be equal to the remaining Rectangle* FC, *or that the Gnomon* DG *may be half of the whole Figure* ABCD *propos'd. Required the Breadth of the said Gnomon* DE *or* BG?
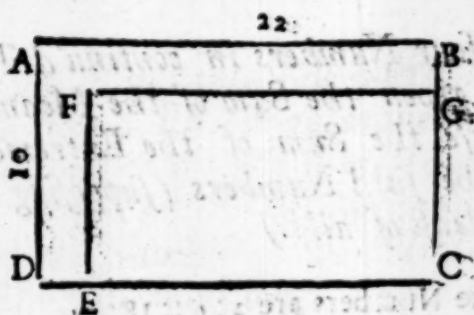
Answer. The Breadth is = 3.917.

72. *Of three proportional Numbers there is the middle Term given,* = 12, *and the Difference of the Extremes* = 10. *Required the Extremes?*

Answer.

Answer. The Extremes are 8 and 18.

73. Of three proportional Numbers there is given the Sum of the first and second, $=$ 10, and the Difference of the second and third $=$ 24. Required the several Numbers.

Answer. The Numbers are 2, 8, 32.

74. Of four proportional Numbers there is given the third $=$ 12, also the Sum of the first and second $=$ 8; beside the second Number being subtracted from its Square, the Remainder is to be the fourth. Required the said Numbers.

Answer. 3, 5, 12, 20. 3 : 5 :: 12 : 20.

75. Of four Numbers in continu'd Proportion there is given the Sum of the Means $=$ 24, and likewise the Sum of the Extremes $=$ 56. Required the said Numbers (supposing that the first is the least of all?)

Answer. The Numbers are 2 : 6 :: 18 : 54.

76. Two Country-women A and B, carry 100 Eggs together to Market; and in the Sale of them one took as much Money as the other; but A (who had the largest and consequently the best Eggs) says to B, had I carry'd as many Eggs as you, I should have had 18 Pence

for them; B replies, *if I had brought as many Eggs as you, I should have had but* 8 *Pence for them.* How many Eggs had each?

Answer. A had 60, and B had 40.

77. *Two Country-men* A *and* B *sell their Corn at different Prices:* A *sells* 20 *Bushels; and* B *received for one Bushel as many Crowns as he sold Bushels:* A *perceives that if he had sold as many Bushels as* B *received Crowns, he should then have received* 252 *Crowns; but both together received* 176 *Crowns.* How many Bushels did B *sell, and what Price had* A ?

Answer. B had sold 6 Bushels, and A had 7 Crowns per Bushel.

78. *Two Merchants sell* 21 *Ells of Cloth: The first sells* 1 *Ell for as many Crowns as is* ⅓ *of the Number of Ells that the second had; and the second sells* 1 *Ell for as many Crowns as is* ⅓ *of the Number of the Ells that the first had. The Sale being over, they had taken* 48 *Crowns in all.* How many Ells did each sell, and at what Price?

Answer. A sold 6 Ells at 3 Crowns *per* Ell, and B sold 15 Ells at 2 Crowns *per* Ell.

79. Two

79. *Two Merchants have a Parcel of Silk,* *the first* 40 *Ells, the second* 90 : *The first sells* *for a Crown* ⅔ *of an Ell more than the second:* *When the Sale was over, they had taken between* *them* 42 *Crowns.* *How many Ells did each of* *'em sell for a Crown?*

Answer. A fold 3 ⅓ and B 3 Ells.

80. *To find a Number, to the Quadruple of* *which if you add* 91, *the Whole shall be to the* *Square of the Number sought, as three to* 4.

Answer. The Number is 14.

81. *To find a Number, from the Double of* *which if you subtract* 12, *the Square of the* *Remainder* — 1, *will be nine times the Num-* *ber sought.*

Answer. The Number is 11.

82 *To divide the Number* 19 *into two Parts,* *so that the Sum of the Squares of the Parts* *will be* 193.

Answer. The Parts are 12 and 7.

83. *To divide* 7 *into two Parts, so that the* *Difference of the Squares, which are made* *from the triple of the less Part, and the double* *of the greater may be* 17.

Answer.

Answer. The greater Part 4, and the lefs 3.

84. *A Man buys a Piece of Linen, and by felling it again, he gains* 12 *Crowns* — $\frac{1}{10}$ *of what he bought it for: And finds by this Means, that he had gain'd as much for* 100 *Crowns, as the Linen coft him. What Price was the Linen bought and fold at?*

Answer. It coft 30 Shillings, and fold it for 39.

85. *A Man buys* 18 *Ells of Cloth of diffe-rent Sorts and Colour, fuppofe Red and Black; what he bought of each coft* 40 *Crowns: And he pays for every Ell of Red Cloth* 1 *Crown more than for the Black. How many Ells of each fort did he buy.*

Answer. 8 of Red, and 10 of Black.

86. *A Man buys* 123 *Pounds of Pepper, and as many of Ginger; and received for a Crown one Pound of Ginger more than of Pepper. So that the whole Price of the Pepper came to* 6 *Crowns more than the Price of the Ginger. How many Pounds of each did he buy for a Crown?*

Answer. 4 Pounds of Pepper, and 5 of Ginger.

87. *A Man buys* 80 *Pounds of Pepper, and* 36 *Pounds of Saffron, fo that for* 8 *Crowns he*
had

had 14 *Pounds* of *Pepper* more than he had of *Saffron* for 26 *Crowns*, and what he laid out amounted to 188 *Crowns.* How many *Pounds* of *Pepper* had he for 8 *Crowns*, and how many of *Saffron* for 26 ?

Answer. 20 Pounds of Pepper, and 6 of Saffron.

88. A and B between them owe 174 *Pounds,* A pays 8 *Pounds* a Day, and B pays the first Day 1 *Pound,* the second 2, the third 3, and so on.   In how many Days will they clear the Debt, and how much did each of them owe ?

Answer. The Debt will be paid in 12 Days, in which Time A pays 96, and B 78 Pounds.

89. *A certain Man intends to travel as many Days as he has Crowns : It happens that every following Day of his Journey he had as many Crowns as he had the Day before, besides two Crowns over and above ; and when he came to his Journey's End, he finds he had in all Crowns. How many Crowns had he at first?*

Answer. He had 5 Crowns.

90. *A certain Traveler goes* 9 Miles a Day three Days after another follows him, who the first Day travels 4 Miles, the second 5, the third 6, and so on, gaining a Mile every Day. In what Time will he overtake the former ?

Answer. In 14.678881 Days.

91. *Two Travelers set out at the same Time from two Cities, the one from* A, *and the other from* B, *which are* 70 *Miles Distant from one another; one of them goes* 6 *Miles every Day, and the other* 2 *Miles the first Day,* 2 *and an half the second, three the third, and so on, adding half a Mile to every Day's Journey. In what Time will they meet with one another?*

Answer. In 7.30891.

92. *Again, Two Travelers set out at the same Time from two Cities, the one from* A *and the other from* B, *which are* 120 *Miles distant from one another; the first goes* 5 *Miles a Day, and the other* 3 *Miles less than the Number of Days in which they meet. When will they meet?*

Answer. In 10 Days.

93. *A Post sets from* A *towards* B, *who travels* 8 *Miles a Day: After he had gone* 27 *Miles, another sets out from* B *to meet him, who goes every Day* $\frac{1}{10}$ *of the whole Journey or Distance of the Places* A *and* B, *and meets the first Post after so many Days as is* $\frac{1}{10}$ *of the said Distance. Required the Distance of* A *and* B?

K   *Answer.*

Answer. The Distance is 189 Miles.

94. *Two Merchants* A *and* B *go Partners,* B *brings* 420 *Crowns, and* A *receives out of his Gains* 52 *Crowns, and the Sum of both their Shares of Stock and Gains, is* 854 *Crowns. How much did* A *bring, and how much did* B *receive out of the Gains?*

Answer. A brought 70, and B gain'd 312 Crowns.

95. *A Son asks his Father how old he was, his Father replies thus ; if you take* 4 *from my Age, the Remainder will be thrice the Number of your Years : But if you take* 1 *from your Age, half the Remainder will be the Square Root of my Age. Required the Age of Father and Son.*

Answer. The Father 49, and the Son 15.

96. *To find two Numbers, the Sum of whose Squares may be* 317, *and the Product, if they be multiply'd by one another,* 154.

Answer. The Numbers are 14 and 11.

97. To

97. *To find two Numbers, the Product of which may be* 108, *and the Difference of the Squares* 63.

Answer. The Numbers are 12 and 9.

98. *Two Farmers fell two forts of Corn:* **A** *fells* 6 *Bufhels;* B *receives in all, for his,* 20 *Crowns: Now fays* B *to* A, *if we add the Number of my Bufhels to the Number of your Crowns, the Sum will be* 28, *Says* A *to* B, *and if I add the Square of my Crowns to the fquare of your Bufhels, the fum will be* 424. *How many Bufhels did* B *fell, and how many Crowns did* A *receive?*

Answer. B fold 18 Bufhels, and A received 10 Crowns.

99. *To find two Numbers, the firft of which* + 2, *multiply'd into the fecond* — 3, *may produce* 110; *and on the contrary the firft* — 3, *multiply'd by the fecond* + 2, *may produce* 80.

Answer. The firft is 8, and the fecond 14.

100. *If the Sun moves every Day one Degree, and the* Moon 13 *Degrees; and at a*
certain

certain Time the Sun be at the Beginning of
Cancer, and in three Days after the Moon in
the Beginning of Aries: The Place of their
next following Conjunction is demanded.

Answer. 10 Degrees and ¾ of *Cancer.* For

$$\frac{13 \times 1 \times 90 + 13 \times 1 \times 3}{13 \times 1 - 1 \times 1} = \frac{1209}{12 \text{ D.}} \text{ or } 100¾ \text{ from } Aries$$

90 Degrees; so will come out 10¾ of *Cancer.*

THE

FOURTH PART

BEING A

MATHEMATICAL

MISCELLANY:

CONTAINING,

I. Sundry RULES to form a pleasing ÆNIGMA; and a proper Mathematical Problem, with Examples. Also to know the fixed Stars and Planets.

II. The Doctrine of ECLIPSES, and how to observe them; with a TABLE of all the visible ECLIPSES that will be in these Parts before 1760.

III. A new and easy Method to calculate the Motions of the PLANETS for any Time past or to come.

IV. A Discourse concerning PENDU-LUMS, the Division and Equation of TIME, and EASTER in particular: With some few PARADOXES left unanswered.

The Fourth PART:

BEING A

MATHEMATICAL MISCELLANY, &c.

Notwithstanding I have already endeavoured to + answer what Expectation the Title may have raised in the Mind of the curious Reader; yet to render this little Manual still more acceptable, I shall subjoin a Fourth Part, containing some necessary Rules, concerning the Formation of a pleasing and diverting *Ænigma*, and *Arithmetical Questions*, with Examples of each: Also how to observe the *Eclipses*, and to know the fixed Stars; with some memorable Observations concerning *Time* and the Equation thereof, *Easter*, and Ship's Distance at Sea, &c.

Seeing *Ænigmas* have of old been the Diversion of Princes, and Entertainment at Feasts, and of late revived among our annual Writers of Diaries, it will not be amiss, for the Information of their ingenious Assistants and Contributors, to exhibit some proper Rules for their Composition generally allow'd of.

An *Ænigma* is then an ingenious and beautiful obscuring the plainest Things; which, when discovered strikes the Soul with Admiration; while we pleasingly wonder, to see how it was possible to lay, as it were, a Veil before the Sun: It is an artificial Representing a Subject under the Shape of another, with so much Cunning, that hides a Thing while it discovers it, and persuades us it is something else than what it is really design'd for.

+ The first Title had only the three Parts aforegoing proposed.

First, That they propose all their *Ænigmas* on Subjects generally known.

Secondly, That they ascribe to no Subject a Property or Quality incoherent to, or inconsistent with it. As for Example: In an *Ænigma* upon *Snow,* it would be very absurd to say, it discolours all the Surface of the Sea, or defies the Fury of *Ætnean* Flames.

Thirdly, That they propose not particular Qualities for general. For tho' by *Synecdoche* we say *Æthiops Albus —— quia albos habet dentes*; yet it would be very improper in an *Ænigma* upon a *Blackamore,* to make him speak in general Terms——*I'm white as Down of Swans, or falling Snow.* Another Caution which may be reduced to this Rule is, That they propose not certain Numbers for uncertain.

Fourthly, That they have a Regard to Time. In treating on Subjects which have been, but now are not: They ought always to speak in the *Preterimperfect Tense,* not in the *Present.* As were I to write an *Ænigma* on *Noah's* Ark 'twould be ridiculous I should say, all Creatures living are within its Womb. This would confine the Answerer's Thoughts entirely to Things now in being. To this Rule may also be added the Regard they ought to have to *Place.*

These are Maxims so plain and common, that it were an Absurdity, one would think, to violate any of them; and yet 'twere to be wished some *Ænigm tists* in the *Diaries* would be tied down to them. Whenever they are violated, 'tis certain the Reader is impos'd upon; for in solving an *Ænigma,* until we can bring it to answer in every Particular, we cannot suppose we have found the Solution. If therefore the Proposer imposes a Falsity upon us, tho' never so small, 'tis still an Objection to our Answer, and we go on beating our Brains in endeavouring to apply to something that which perhaps is not applicable to any thing.

Example.

Example I.

THE charming *Phillis* once was wond'rous fair,
   Each Youth's Delight, her Parents only Care,
Admir'd and lov'd by all the neighb'ring Swains,
And own'd the lovelieft Nymph that grac'd the Plains
Orant fhe lov'd, of mean and low Degree,
A Servant in her Father's Family.
Her Parents knew how fhe her love had plac'd,
Yet blam'd her not, becaufe they faw 'twas chaft;
One Hour to her each Morn they freely grant,
For private Converfe with her dear *Orant.*
Unfkill'd in Language he her Heart beguiles,
With amorous Looks, and with obliging Smiles;
All fhapes he wore, yet ne'er by her was feen
Without a beauteous Face and lovely Mien.
   When thus he had her youthful Heart betray'd,
A foul Diftemper feiz'd the blooming Maid;
Long time a burning Fever rag'd within,
And rifing Puftules fpoil'd her lovely Skin.
   While thus fhe lay, th' indulgent Mother near,
O give me leave once more to fee my dear!
My dear *Orant!* She faid, 'twill eafe my Pain,
If I can once behold *Orant* again:
Why muft I now in vain with Tears implore
That Favour which was ne'er deny'd before?
   Her Mother cry'd, my Child, take no Offence,
Your Suit is now of dang'rous Confequence;
I can't permit you once to fee your Love.
'Till Time fhall this Diforder quite remove.
   At length perceiving fhe was left alone,
And her Defire, as yet, fulfill'd by none,
UP ftarts th' impatient Maid without Delay,
And to *Orant*'s Apartment found the Way;
She found the Object of her Paffion too,
And cry'd, *What fays he to his* Phillis *now?*

Yo

You're foul, you're monftrous grown (faid he) *therefore*
Henceforth I'll fee that loathfom Face no more.
Impatient of the Wrong, fhe turn'd afide,
And fnatch'd a Dagger, which by Chance fhe fpy'd.
Then, half diftracted, to the Scorner flew,
And at his Breaft the pointed Weapon threw:
I'll make thee feel, ungrateful Wretch; fhe faid,
The juft Refentment of an injur'd Maid.
Pierc'd thro' and thro', he fell upon the Ground,
While fhe without Remorfe, purfu'd the Wound:
With unrelenting Rage fhe trampled o'er
His Body, which with utmoft Rage fhe tore:
And ftrow'd his mangled Limbs upon the Floor.

    Ladies, no doubt this feems a monftrous Tale,
But if I fhould the Myftery reveal,
You'll own at laft the Story may be true:
And has been acted o'er by fome of you.

Anfwer. *A Lady beholding her Face in a* Looking-Glafs,
after the Small-Pox.

Example II.

FRom Shrubs and from Trees, and vaft Caverns be-
    low.
And the Sweat of Mens Bodies, our Beings we owe:
But we're odd kind of Beings, and ftrange Pranks
    have play'd,
Some we have delighted, and fome made afraid
If two of us meet, Sir, nay, if we be three,
All Things topfie-turvey we turn prefently:
But then if our Number increas'd is to four,
We fet all Things to rights, Sir, as they were before:
No Hands ever had we, or Colour e'er faw,
Nor ever us'd Croyon or Pencil to draw:

                             Yet

Yet we paint with such delicate Colour and Shade,
And in such true Proportion our Figures are made,
That we challenge *Van Dike* and the fam'd *Angelo*;
Such excellent Pieces, as ours are, to show.

Answer. By the Help of *Telescope Glasses* may be repre-
sented in a *darkned Room* (as I have often my self ex-
perienced) the most lovely and charming Colours
Proportions and Distances of all outward Objects
vastly surpassing all that ever the most celebrate
Painters could perform. A clear Account of thi
most wonderful and glorious Experiment. I shal
here give you from the best Authors, and from m
own Experience.

Procure a good Convex or Plano-Convex Glass; or
if you take the object Glass of a Seven-Foot Telescop
there is none hardly to be preferred before it; then
being several Inconveniences in Glasses, that draw a
bove or under that Distance.

Make choice of a Room that hath got a *North* Win
dow (tho' an *East* or *West* may do pretty well) and le
it be well-darkned, so that no Light can come in. b
at the Hole where your Glass is to be placed: The
make a Hole in the Shutter of the *North* Window,
bout an Inch (or very little more) in Diameter, an
leave open the Casement, if there be one; for the
must be no Glass beyond the Hole: then fasten t
Glass with its Center, in the Center of the Hole, b
some small Tacks or Nails to the Shutter, and at t
Distance your Glass draws, hang up a white Sheet; (o
which is all one, move the Sheet to and fro ti
you find the outer Objects are represented on it ver
distinctly) then fasten the Sheet to the Cieling wi
Nails: Then will, whatever is without the Hole, an
opposite to it, be represented on that Sheet, with su
exquisite Exactness, as far surpasses the utmost Skill
any Painter to express. For if the Sun shine brig
ly on the Objects, you will have the Colour of
things there in their natural Paint, and such an

mirable Proportion of Light and Shadow, as is impossible to be imitated by Art; and I never saw any thing that comes so near this natural Landskip: But if the Sun do not shine the Colours will be hardly visible; and you must by all means avoid the Sun's shining near the Hole, for then all things will be confused.

And here you have not only the Representation of outward Objects, but their very Motion also, expressed on your white Cloth : If the Wind move the Trees, Plants or Flowers without you have it within on your lively Picture; and nothing can be more pleasant, than to see how the Colours of the moving Parts will change as they do without, by their being in various Positions obverted to, or shaded from the Light.

The Motion of any Birds, Flies, or other Insects, are painted also in the same Perfection; and the exact Lineaments of any Person walking at a due Distance without the Glass, will be also expressed to the Life; and all their Motions, Postures and Gestures, will as plainly appear on the Cloth, as they do to any one's eye without.

And nothing is wanting to render it one of the finest Sights in the World, but that all things are inverted, and the wrong End upwards; to remedy which, take a common Looking-Glass of twelve or fourteen Inches square, and hold it under or near the Chin with an acute Angle to your Breast : For if you do so, and look down into it, you will see all things upon the Sheet inverted in the Glass; and so (in this Case) will be restored to their natural and erect Positions; and this reflexion also from the Glass, gives it a Glaringness that is very surprising, and makes it look like some magical Prospect; and the moving Images, like so many Spectrums or Phantasms. And no doubt there are many Persons, that might easily be imposed upon with such a Scene; and would not be persuaded but that it was downright Conjuration.

I have

I have (saith Mr. *Harris*) *made use of this Experiment to convince some credulous Persons that those are abused and imposed upon,* who see Faces in the Glasses of some cheating Knaves *amongst us, who set up for cunning Men, and discoverers of stolen Goods. &c. and have satisfied them, that much more may be done by this and some other optical Experiments, and that without the Help of the Devil too, than by any of the clumsy Methods used by these Vermin.*

If the Glass be placed in a Sphere, or Globe of Wood (having an Hole as large as the Glass, bored thro' it) which like the Eye of an Animal may be turned every Way, to receive the Rays coming from all Parts of the Objects, it will be of good Advantage to the Experiment.

You may with this Glass also (as well as with a Concave one) make that little Machine called the Magical Lanthorn; by Means of which are represented on Wall in the dark, many Phantoms and terrible Apparitions, which are taken for the Effects of Magick by those that are ignorant of the Secret. The Theory of this Lanthorn is fully explained by Mr. *Molyneux* in his excellent Book called *Dioptr. Nova.* Prop. 56 pag. 183. and the Machine at large described; to which I refer my curious Reader.

And thus is one Part of the *Example* explained. And this also explains two more of the former Lines in their Words.

But we're odd kind of Beings, and strange Pranks have play'd,
Some we have delighted, and some made afraid.

By which is meant, those glorious Representations of Objects in a darkned Room, upon a white Cloth (or Paper) as I have before described; and the frightful Apparitions made by the Magick Lanthorn just now mentioned. As for the two first Lines.

From Shrubs and from Trees, and vast Caverns below,
And the Sweat of Mens Bodies, our Beings we owe;

is meant the Materials with which Glafs is made, which is from the Shrub called *Kali* and *Wood-Afhes*, and divers other Things, which, with Coals drawn out of the Bowels of the Earth, are melted; and is the hotteft Work in the World, in Blowing and Grinding, caufing the *Operators* to fweat in a plentiful Manner.

SECTION II.

Some ufeful and neceffary Hints for the pleafing Compofition of proper Arithmetical Queftions; by Perfons of a good Mathematical Genius.

I. THE moft natural Method in anfwering the Queftions, fhould be a little regarded in the Compofition.

II. No Queftion that can be anfwered two Ways fhould be allow'd of, which will neceffarily lead fome from the expected Anfwer.

III. Nothing that is very paradoxical, much lefs naturally impoffible, and void of Demonftration, fhould be put for an *Arithmetical Queftion.*

IV. No ambiguous or doubtful Words fhould be ufed, but fuch as are plain and eafy to be underftood.

V. We fhould ufe the fame Terms of Art with the lateft and beft Authors; or at leaft our Terms and Phrafes fhould be fo plain and eafy, as that none may be miftaken or deceived by them: For I think it is much better and more improving. to invent fomething ingenious than abftrufe. Nor do I fee any great Benefit or Difficulty in puzling Mankind, and racking their Brains; nor is it neceffary when there is fuch an infinite Variety in the Mathematicks of pleafant and profitable Propofitions. All Kind of Learning

L

is

is difficult enough, especially the Mathematical, to take up the short Intervals of our Time, without being made more tedious and laborious ; therefore we should make it our chief Aim to facilitate and abridge it.

Example I.

WHen fleecy Skies had cloath'd the Ground,
  With a white Mantle all around,
Then with a Greyhound, snowy fair,
In Milk-white Fields we cours'd a Hare ;
Just in the Midst of a Champain,
We set her up, away she ran :
The Hound (I think) from her was then,
Just thirty Leaps (or three times ten)
Oh! it was pleasant for to see,
How th' Hare did run so timorously,
But yet so very swift that I,
Did think she did not run, but fly :
When th' Dog was almost at her Heels,
She quickly turn'd, and down the Fields
She ran again, with full Career,
And 'gain she turn'd to th' Place she were ;
At ev'ry Turn she gain'd of Ground
As many Yards as the Greyhound
Could leap at thrice, and she did make
Just six (if I do not mistake)
Four times she leapt for the Dogs three,
But two of the Dog's Leaps agree
With three of hers.   Now pray declare,
How many Leaps he took to catch the Hare.

Answer

Answer.

LAST *Winter* when the Fields were cloath'd,
And to the Milk-white Snow betroth'd,
When Trees were cropt by frosty Weather,
Their Buds and Leaves lay mixt together
Sol did in *Capricorn* appear,
And made short stay in this our Hemisphere;
The Time, I very well remember
Was in the Middle of *December*:
A Knot of jovial Blades did meet,
And that our Mirth we might complete,
Into the snowy Fields we went,
To course the Hare was our Intent;
We beat the Fields with wond'rous Care,
At last we found a boxing Hare,
Just in the Midst of a Champain
We set her up, away she ran,
With nimble Foot, o'er a large Plane.
Don't wonder I use Mr. *Walker's* Verse,
When I this coursing Match rehearse;
For we had there the same Greyhound,
And with him cours'd the Hare around;
I well observ'd when we did find her,
The Dog was thirty Leaps behind her.
It pleas'd me so, methinks I see
The frighted Hare run timorously:
The Dog being almost at her Heels,
With Motion swift about she wheels.
With full Carreer away she ran
To th' Place where she at first began;
Six Turns in all the Hare did make,
Their Number you did not mistake;
Proportion due I did compare,
Between the Leaps o'th' Dog and Hare
For her four Leaps the Dog made three,
The Sport was charming for to see;

Her Three, did two of his contain,
So one in nine the Dog did gain;
How many Leaps to catch the Hare
The Dog did take, I shall declare,
Four hundred and just thirty two
They were, and so, good Sir, adieu.

Example II.

MR. *Richard Wrag* made a Voyage to *Constantinople*
with Mr. *Barton*, Queen *Elizabeth's* Ambassa-
dor: And during his stay there, upon the 16th of *July*,
1594, for his Diversion he made a Trip to the *Euxine*
or *Black-Sea*; his Relation of it is thus, The 16th of
July, accompanied with some other of our Nation,
we went by Water to the *Black-Sea*, being 16 Miles
from *Constantinople*; the Sea being all the Way thither,
little broader than the *Thames*: Both Sides of the Shore
being beautified with fair and goodly Buildings: At
the Mouth of this *Bosphorus* lieth a Rock some 80
Yards from the Main Land, whereupon standeth a
white Marble Pillar, call'd *Pompey's* Pillar, the Shadow
whereof was 22 Foot long, at 9 of the Clock in the
Forenoon (which is all he says of it to our Purpose;
leaving the Height of the Pillar undetermined.) Now
the Latitude of the Place being found to be 41 Deg.
8 Min. it is required to find the Height of the Pil-
lar.

Answer. The Sun's Longitude *July* 16, *Anno* 1594, at
9 of the Clock in the Forenoon, is according to the
Caroline Tables, 2 Deg. 47 Min. 31 Sec. in *Leo.* Thence,

1. To find the Sun's Declination.

	deg.	min.	sec.
As Radius or Sine of ———— —————	90 :	00 :	00
To the Sine of the Sun's Distance from the next Equinoctial Point :	57 :	12 :	29
So is the Sine of the Sun's greatest Dec.	23 :	30 :	00
To the Sine of the Sun's Declination at the Day and Hour aforesaid.	19 :	35 :	06

2. To find the Sun's Height.

As the Radius or Sine of —————	90 :	00 :	00
To the Cotangent of the Poles Height	48 :	52 :	00
So is the Sine of the Sun's Distance from the Hour of 6 viz. ———— ————	45 :	00 :	00
To the Tangent of an Arch, viz. ————	38 :	59 :	40

Which being subtracted from the Complement of the Sun's Declination, say,

As the Cosine of the Arch found ———	51 :	00 :	20
To the Cosine of the remaining Arch of the Sun's Distance from the Pole ——	58 :	34 :	46
So is the Sine of the Pole's Height ——	41 :	08 :	00
To the Sine of the Sun's Height at the Day and Hour aforesaid. —— ——	46 :	14 :	32

3. To find the Height of the Pillar.

As Cosine of the Sun's Height ——	43 :	45 :	28
To the Length of the Shadow 23 Feet,			
So is the Sine of the Sun's Height ——	46 :	14 :	32

To the Height of the Pillar 24.0196 Feet.

The Operation of Logarithms is left to the Reader to perform at his Leisure.

SECTION III.

By what Means we may know the Stars in the Heavens.

I. BY having the Picture or Reprefentation of the Conftellation by you, and knowing one or more Stars of the fame Conftellation, by comparing the Stars in the Picture or Figure, and thofe in the Heaven : And confidering their Situation, Diftances and Magnitudes in the one, you may eafily find out thofe in the other.

II. By the paffing of fome of the Planets, but efpecially the Moon, thro' the Signs, or by fome Eminent Stars.

III. By their coming to *South*, and if withal, you have their Height given, and then by a Quadrant find their Height in the Heavens, you may, with great Certainty and Eafe find them out.

IV. By their Rifing and Setting, when and on what Point of the Compafs ; or by their Azimuth and Altitude, ufing only a Quadrant and a Compafs.

V. By fome Inftrument as the Hemifphere, Globes, or a Speaking-Tutor, who can point them out with Speed and Certainty.

To diftinguifh Planets from fixed Stars.

Planets rarely twinkle. *Jupiter* and *Venus* are bigger than fixed Stars, they fhift their Places from a fixed Star confiderably in a Week or two : Alfo by an *Ephemeris* ; fee what Conftellation they are in : *Jupiter*
and

and *Venus* are of the firſt Magnitude, *Mars* of the ſecond, *Saturn* and *Mercury* of the third: *Saturn* of a Lead Colour, *Jupiter* of a Silver, *Mars* of a Copper, *Venus* like gliſtening Silver, not far from the *Sun*, and *Mercury* like Quick-ſilver, ſeldom viſible, and always near the *Sun*.

SECTION IV.

Concerning Eclipſes, *and how to obſerve them with Safety, Pleaſure and Profit.*

WHen we conſider the Penetration and Contrivance neceſſary to lay the Foundation of Aſtronomy, we cannot but admire its firſt Inventors, ſuch as *Thales, Mileſius,* who is ſaid firſt to have predicted Eclipſes : His Scholar *Anaximander,* who found out the Globous Figure of the Earth, the Equinoctial Points and Principles of Dyalling, and made the firſt Sphere or Image of the Heavens: And alſo *Pythagoras* or his Scholars, to whom we owe the Diſcovery of the beſt Syſtem of the Planets. who were probably aſſiſted by the *Chaldeans* and *Egyptians,* among whom (*Joſephus* informs us) Abraham *read Lectures of Aſtronomy and Arithmetick, which Sciences the* Egyptians *underſtood nothing of, till* Abraham *brought 'em from* Chaldea *into* Egypt, *and from thence they paſſed to the* Greeks. See Antiq. Book I. Ch. 9.

But the Aſtronomers of our Age have attained to much greater Perfection in theſe Matters, eſpecially in Eclipſes of the Sun, which are much more difficult than *Lunar.* The Eclipſe of the *Moon* has the ſame Appearance to all Spectators at the ſame Inſtant: Whereas that of the Sun may appear to one Part of the Earth totally obſcured, to another but in Part, on its *North's* Side, to a third on its *South* Side, and to a fourth not at all; and all this at the ſame Moment of Time.

Hence

Hence it is, That the *Lunar* Eclipses equally happening at the same Instant to that Hemisphere to which the Moon is then visible, may be reduced to any other Meridian by allowing the Time, belonging to the Difference of Meridians after the Calculation is ended : But an Eclipse of the Sun must be calculated for every different Meridian, if you will have its true Appearance, which much encreaseth its Difficulty, and among other Things made the Antients to err so much, and so often herein : Wherefore after the true Conjunction is found, change the Time by the Tables into the Time proper to another Meridian, by allowing its Difference, to which Time and Place find the Parallaxes, &c. For the Parallax of the Moon differs in every Climate, on which the visible Eclipse of the Sun principally depends.

The Moon having only a precarious Light, is covered with real Darkness, whenever the Earth robs it of the Sun-Beams. But the Sun, on the contrary, which is Luminous, or rather Light it self, can never be really darkned by the Moon's covering it, only in Appearance to the Spectators under its Shade; it is not the Sun but the Earth that is in Darkness. Hence it may more properly be termed an Eclipse of the Earth than of the Sun; yet because of Custom, and the seeming Darkness over the Sun, I retain the common Phrase of the Eclipse of the Sun.

In general, there are more Eclipses of the Sun than of the Moon, but Eclipses of the Sun in any particular Place are much fewer than of the Moon, because the Moon's Shadow is less than the Earth's, and consequently does not involve any given Place of the Earth so oft as the Earth's Shadow does some Part of the Moon. The Moon oftner takes away the whole Sun from the Earth, than the Earth takes away the whole Sun from the Moon; the Body of the Earth being larger, receives more Transits of the Moon's Shadow, than the Moon of the Earth's Shadow; and because the Sum of the Semidiameters of the Moon and the Earth is never less than 54 Minutes, and the Semidia-

diameters of the Sun and Moon never greater than 34. The Eclipse of the Moon may happen in a greater Latitude of the Moon than the Solar; and in respect of one and the same Place upon the Earth, the Eclipses of the Moon will be more frequent; tho' in respect of the whole Earth, Solar Eclipses may exceed in Number.

Moreover, because for many Days together, the Sun's Place is once every Year but a little distant from either Node, during which time there happen generally two Syzyges; and consequently Eclipses which are the greater, the nearer any New or Full Moon happens to the said Nodes, which Nodes are the Sections of the Moon's Orbit with the Ecliptic: In a Year there happen seldom less than two, or more than six Eclipses.

Astronomers affirm the Sun may be eclipsed more than 12 Digits, and the Moon 22 (if it had them) for a Digit is one 12th Part of their Diameter. The Sun is seldom totally eclipsed in one Place, the Moon often: And the greatest Shadow the Moon hides, is not above 200 Miles, being the greatest Difference of the Sun and Moon's Diameter, which according to the Obliquity of Horizons is greater or less. The End of the Shadow, whether of the Moon or Earth, falls short of the other Planets, and therefore they eclipse none but each other.

The Sun's Eclipse arises sooner to those that inhabit the *Western* Parts, and later to those more *Easterly*, because the Moon's proper Motion from *West* to *East* is swifter than the Sun's near 13 times; and therefore it begins on the *Western* Limb of the Sun, which Part is first restored to Light again: And if the Moon's visible Latitude be *North*, the *North* Part, but if *South*, the *South* Part of the Sun is darkned, because the Moon intercepts the Light of the Sun, on the same Side of the Ecliptic the Moon appears.

The Sun's Eclipse lasts not so long as the Moon's, the Sun's in any Place seldom exceeding two Hours, but the Moon's sometimes more than four; because the

Moon

Moon each Hour goes through half a Degree about the Length of the Sun's apparent Diameter, which the Moon muſt be one Hour covering, and another Hour uncovering, about four Hours in all. Solar Eclipſes alſo are very different each from other, not only becauſe of the unequal, and uncertain Motion of the Moon, both true and apparent, the greater or leſſer viſible Latitude of the Moon's Diſtance from the Sun, and unequal Diſtance of both the Luminaries from the Earth; tho' Eclipſes may happen pretty near the ſame Time and Place, yet they will not, for the above Reaſons, be of the ſame Quantity and Duration; for this Rule is certain, *The Heavenly Motions are incommenſurable among themſelves, nor have the ſame Phænomena in every Reſpect, return'd alike in any Place.*

For the neweſt and exacteſt Method of calculating Eclipſes, ſee Dr. *Gregory*'s Aſtronomy, Book 4. Sect. 7. 8. and Mr. *Flamſteed*'s Doctrine of the Sphere in Sir *Jonas Moor*'s Syſtem of the Mathematics.

Eclipſes are of manifold Uſes in Aſtronomy, Geography, Chronology, and Navigation, to correct their Tables, Maps, Globes, Account of Time, and contribute very much to the Diſcovery of Longitude both by Sea and Land; and by the Wings of Eclipſes and Parallaxes the Mind of Man flies up, and penetrates into the Celeſtial Regions: Theſe are the Charms, as ſaith the Poet, *which draw down the Sun and Moon on Earth*; or more truly the Knowledge of them to the inquiſitive Inhabitants of the Earth; nor do I know a more evident and illuſtrious Proof of Aſtronomical Truth in Hypotheſes, or Tables, than may be had from Solar and Lunar Eclipſes.
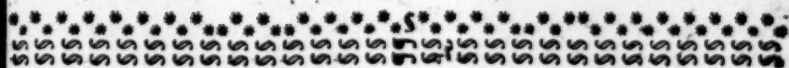
To behold the Eclipse without Hurt to the Eyes.

SOME simply prick a small Hole in a Sheet of Paper, others use a Looking-Glass; but a better Way is coloured or smoaked Glass, which defends the Eye from the Beams of the Sun, or by a Burning-Glass, reflecting it on a clean Sheet of Paper, held twice as far from the Paper as for Burning.

Tho' I don't here intend to prescribe a Method to those Gentlemen that are furnished with Astronomical Machines, such as large Quadrants, Sextants, whereunto are affixed Telescopic Sights, yet I shall humbly offer a ready Astronomical Apparatus for others.

Prepare a Sheet of Paper, whereon is drawn a Circle, about 6 Inches Diameter, divide its Circumference into 360, its Diameter by 6 Contentric Circles, into 12 equal Parts for the Digits; and another Diameter for Decimal Parts into an 100, whereby the Proportion of the light and dark Parts to each other may be known; the 360 on the Limb, may serve to determine the Inclination of the Cusps of the Shade, this paste on some Wall, or Board which is better.

Then Rule a Paper, like a Surveyor's Field-Book, in 9 or ten Columns, for the Uses following.

Obser-

Observations common to the Eye: as Appearances of the Sky, Colour of the Eclipse, Stars seen, Candles lighted, or Birds flying towards their Nests.	Number of Observations.	Digits and Parts.	Decimal Parts.	Time by Pendulum.	Time by a Sun-Dial.	Sun's Altitude.	Time Corrected.	Astronomical Observations: as Sun's Azimuth, Inclination of the Cusps, Semidiameter of the Moon, bigger or less than the Sun, whether it grows bigger or less; whether the Moon has an Atmosphere, especially to be observ'd, where total Darkness happens by red Streaks of Light before and after it; also how long they are visible.

Then prepare a large Prospect with two Glasses, the Eye-Glass Concave, the Object Convex, and affix it to a Surveying Instrument, or the like, with a Ball and Socket, that it may move higher or lower, or to any Point of the Compass; and let it stand at such a Distance from the Sheet aforesaid, as just to reflect the Species of the Sun to the like Diameter already thereon drawn; which let one or two mind how the Shade commences, another observe the Sun's Altitude by a Gnomon and End of its Shadow, whether Wall or Stake; if you have no Quadrant large enough, let some other mind the rectified Pendulum or Sun-Dyal, and give Account of the mean and apparent Time and Register in their proper Columns; particularly noting the Beginning and End of total Darkness, and of the whole, when also each Digit is eclipsed, if the Air be clear, also the Angle of Incidence, &c.

Note, The principal Things to be minded are, 1. The exact Time of the Beginning and End of the Eclipse, and of total Darkness, when and where such Eclipses happen. 2. The Duration of total Darkness. 3. The Difference of the Colour and Temper of Light. 4. the red Streaks of Light just preceding and following the total Darkness, being Indications of an Atmosphere about the Moon.

The Method of obſerving Eclipſes of the Moon.

EClipſes of the Moon, are obſerved for two prin-
cipal Ends; one Aſtronomical, that by compa-
ring Obſervations with Calculations, the Theory of
the Moon's Motion may be perfected, and the Tables
thereof reformed: The other Geographical, that by
comparing among themſelves, the Obſervations of
the ſame Ecliptic Phaſes made in divers Places, the Dif-
ference of Meridians or Longitude of Places may be
diſcerned.

The Knowledge of the Eclipſes, Quantity and Du-
ration, the Shadows, Curvity and Inclination, &c.
conduce only to the former of theſe Ends. The ex-
act Time of the Beginning, Middle, and End of the
Eclipſes, as alſo in total Ones. The Beginning and
End of total Darkneſs, is uſeful for both of them.

But becauſe in Obſervations made by the bare Eye,
theſe Times conſiderably differ, from thoſe with a
Teleſcope, and becauſe the Beginning of Eclipſes,
and the End of total Darkneſs, are ſcarce to be ob-
ſerved exactly even with Glaſſes, (none being able to
diſtinguiſh between the true Shadow and *Penumbra*,
unleſs he hath ſeen for ſome Time before, the Line ſe-
parating them, paſs along upon the Surface of the
Moon.)

Laſtly, becauſe in ſmall Partile Eclipſes, the Begin-
ning and End in total Ones of ſmall Continuance in
the Shadow, the Beginning and End of total Dark-
neſs are unfit for nice Obſervation, by Reaſon of the
ſlow Change of Appearances which the oblique Mo-
tion of the Shadow then cauſeth. For theſe Reaſons,
the following Method is neceſſary to accompliſh the
Geographical Ends in obſerving Lunar Eclipſes, free
(as far as is poſſible) from the forementioned Incon-
veniences.

Firſt, it ſhall not be practicable without a Tele-
ſcope. Secondly, the Obſerver ſhall always have Op-
portunity, before his principal Obſervation, to note
the Diſtinction between the true Shadow and *Penum-*

bræ.

bra. And Thirdly, it shall be applicable to those Seasons of the Eclipse, when there is the suddenest Alteration of the Appearances for these Intents. Let there be of the eminentest Spots dispersed over all Quarters of the Moon's Surface, a select Number generally agreed on, to be constantly made Use of to this Purpose, in all the Parts of the World; as for Example, those which Mr. *Hevelius* calleth *M. Sinai, M. Æt-na, M. Porphyrites M. Serorum, Inf. Bethica, Inf. Creta, Palus Mæotis, Palus Maræotis, Lacus Niger Major.* Let in each Eclipse, not all, but (for Instance) three of these Spots which lie nearest to the Ecliptic be exactly observed, when they are first touched by the true Shadow, and again, when they are completely entred into it, also in the Decrease of the Eclipse, when they are first fully clear from the true Shadow. For the accurate Determination of which Moments of Time, (that being in this Business of main Importance) let there be taken Altitudes of remarkable fixed Stars, not only on this Side the Line, of such as lie between the Æquator and Tropic of *Cancer,* but beyond the Line of such as are situate towards the other Tropic, and in all Places of such as at the Time of Observation, are about four Hours distant from the Meridian.

To observe a Solar Eclipse.

First prepare a Room well darkned, into which cast the Sun's Rays through a Telescope of a competent Length as aforesaid, to the End of which fix a Paper, pasted on a small Board, at such a Distance, that the Species of the Sun may appear thereon about five or six Inches over; then divide the Periphery into three hundred and sixty Degrees, *&c.* For the better observing the Inclination of the Cusps of each Phasis, and its Diameter into Digits and Parts, by concentric Circles for the measuring the obscured Parts. Cross those Circles at right Angles, to which hang a Line and Plummet, by which you may keep the vertical and horizontal Circles in their due Situation.

There

There is a certain Period of Eclipses, called by Dr. Halley the *Chaldean Saros*, which in Leap-Years is eighteen Years, eleven Days, seven Hours, forty three Minutes, and fifteen Seconds; but in a common Year is eighteen Years, ten Days, seven Hours, forty three Minutes, fifteen Seconds. This Period may serve very well for common Use to examine Eclipses by, but not to trust to for the precise Time.

Its Use, by Examples from Black-Monday*, which was*

Y.	D.	H.			Y.	D.	H.
				And from the same to move backwards.			
1652 *March* 28 :	22				1652 *March* 28 :	22	
18	10 :	7			18	10 :	7
1670 *April* 8 :	5		*because Leap-Year*		1634 *March* 18 :	15	
18	11 :	7			18	10 :	7
1688 *April* 19 :	12				1616 *March* 8 :	8	
18	10 :	7			18	11 :	7
1706 *April* 29 :	19		*because Leap-Year*		1598 *Feb.* 25 :	1	
18	11 :	7					
1724 *May* 11 :	2						
18	10 :	7					
1742 *May* 21 :	9		*because Leap-Year*				
18	11 :	7					
1760 *June* 14 :	18						

And from the same to move backwards.

Y.   D.   H.

On which Day about Noon happened such another dark Day; and therefore about an

Age ago was denominated *Black-Saturday.*

Note, In all these Days past were great Eclipses of the Sun, either visible or invisible.

M 2

I will

I will close this *SECTION* with a Recapitulation of the Difference between an Eclipse

of the Moon, which is

1. A true Obscuration or Defect of the Moon.

2. 'Tis from the Shade or Penumbra of the Earth interpos'd betwixt Moon and Sun.

3. It can only be seen by Night, or near it.

4. It only happens in the true Opposition.

5. It appears in all the nocturnal Hemisphere, every where of the same Magnitude and Duration.

6. It begins in the *Eastern* and ends in the *Western* Limb of the Moon.

7. If the true Latitude of the Moon be *North*, then in the Middle of the Eclipse the obscure Part of the Moon tends towards the *South*, if the Latitude be *South*, it tends towards the *North*.

8. Its greatest Duration is when the Moon is in *Perigæo* about four Hours.

and Eclipse of the Sun, which is

1. A true Obscuration, not of the Sun, but of the Earth.

2. 'Tis from the Shade or Penumbra of the Moon interposed betwixt the Sun and Earth.

3. 'Tis only seen by Day, or near it.

4. It only happens in the visible Conjunction.

5. It doth not appear in the whole diurnal Hemisphere; but to some it is greater and longer, to some it appears less and shorter, to some it appears total or annular, to others horn'd, or none at all.

6. It begins in the *Western* Margin of the Sun, and ends in the *Eastern*.

7. If the visible Latitude be *North*, the obscured Part of the Sun in the Middle of the Eclipse tends to the *North*. if *South*, towards the *South*.

8. Its greatest Duration is when the Sun is in *Apogæo* and Moon in *Perigæo* about three Hours in one Place, and five Hours in different Places.

9.

9. It happens oftner than the Solar Eclipse in the same Place.

10. In the same Year there cannot be above 3 Eclipses of the Moon.

9. It happens oftner than the Lunar in divers Places.

10. In one Year there cannot happen above 5 Solar Eclipses.

In half a Year's Time may happen two central Eclipses of the Sun, or almost central, and then all that Year will be no Lunar Eclipses.

In no Year will happen less than two or more than eight Eclipses. The total Eclipses of the Sun are more than the total Eclipses of the Moon.

SECTION V.

A new and ready Way to calculate the Motions of the Planets, for any Time past, or to come.

FOr *the Sun.* Add 1 Minute, 56 Seconds to his Place 4 Years before the given Time, and the Sum is his exact Place for the given Time; so you may rise to any Year to come by this proportionable Addition; and likewise look back to any Number of Years; for the Time past, by deducting one Minute, 56 Seconds, for every fourth Year.

For the Moon. Look in an Ephemeris for twelve Years before, and if you would know the Place of the *Moon* for the 1st of *January*, see the Place of the *Moon* the 27th of *February* 12 Years before, and add four Signs 1 Degree 5 Minutes to the *Moon's* Place that 27th of *February*, and the Total is the Place of the *Moon* on the 1st of *January*, desired, so shall you be sure to have the *Moon's* Place within a few Minutes (when it differs most from the Calculation by the Tables) but for the most Part it will not differ at all; and thus proceed from Day to Day out of the old *Ephemeris* adding still 4 S. 1 Degree, 5 Minutes, and write it against the answering Days of the new *Ephemeris* successively.

M 3

For

For *Saturn*, 1 *January*, 1669. I take an Ephemeris for 29 Years before, *viz.* 1640, then compute the Diſtance of *Saturn* from the *Sun* on the laſt of *December* in the Ephemeris for the Year 1668, and having done this, I run my Eye up and down in the Ephemeris 1640. in the Beginning of *January*, or elſe in the End of *December*, 1639, till I find *Saturn* at the ſame Diſtance from the *Sun* that he is the laſt of *December* 1668; then I conſider his daily Motion from that Day to the next, and the ſame I allow him from the laſt of *December* to the firſt of *January* 1669, and ſo from Day to Day, allowing him more or leſs for his daily Motion, according as I find the Motion of *Saturn* either encreaſed or diminiſhed in the old Ephemeris at the ſame Diſtance from the Sun.

For *Jupiter*. Take an Ephemeris for 12 Years before, or 83 Years before, and do as for *Saturn*, conſidering the daily Motion of *Jupiter* in the old Ephemeris, at the ſame Diſtance he is that Day that you deſire to know his Place for.

For *Mars*. Take an Ephemeris for 79 Years, and do in like Manner.

For *Venus*. Take an Ephemeris for 8 Years, and do ſo.

For *Mercury*. Take an Ephemeris for 13 Years, and do ſo.

Omne bonum melius quo communius.

Queſtionleſs, much more may be done, to which I hope the Ingenious will be prompted on by this ESSAY.

SECTION VI.

A Table of all the viſible Eclipſes of Sun *and* Moon *from the Year* 1730 *to* 1760, *under the Meridian of* London.

Year

Year	Mon D. H. M.	Long. ☽ D. M.	Lat. ☽ D. M.	Digits M. D.	
1730	Jan. 22 15 34	♌ 14 10	0 46 S A	2 53	☽
	July 3 15 26	♋ 22 15	0 15 S A	6 7	☉
1731	June 8 13 55	♐ 28 4	0 55 S D	1 52	☽
1732	Nov. 20 9 59	♊ 10 2	0 3 N D	20 48	☽
	Dec. 5 21 12	♐ 25 48	0 32 N A	0 1	☉
1733	May 2 6 37	♉ 22 52	0 8 N D	9 20	☉
	May 17 6 56	♐ 8 17	0 32 N A	8 25	☽
1735	Sep. 20 13 33	♈ 8 18	0 39 N D	5 37	☽
1736	Mar. 15 11 52	♎ 6 39	0 1 N A	21 45	☽
	Sep. 8 14 24	♓ 27 19	0 1 S A	20 32	☽
1737	Feb. 18 3 4	♓ 11 9	0 39 N D	10 55	☉
	Aug. 28 15 44	♓ 16 22	0 42 S A	4 34	☽
1738	Aug. 3 23 3	♌ 22 14	0 21 S D	4 8	☽
1739	Jan. 13 10 54	♌ 4 38	0 37 S D	6 22	☽
	July 24 4 23	♌ 11 39	0 12 N D	7 6	☉
	Dec. 18 20 49	♑ 8 19	0 27 N D	2 10	☉
1740	Jan. 2 10 25	♋ 23 10	0 1 N A	20 29	☽
	Dec. 23 11 49	♋ 11 46	0 40 N A	5 49	☽
1743	Oct. 21 15 35	♉ 9 17	0 1 S D	21 30	☽
1744	Apr. 15 8 32	♍ 6 51	0 35 S A	8 0	☽
1746	Aug. 19 12 5	♓ 7 18	0 39 S D	6 6	☽
1747	Feb. 13 17 2	♏ 6 18	0 5 S A	19 42	☽
1748	July 13 22 30	♌ 2 38	0 4 N D	9 53	☉
	July 28 11 34	♒ 16 32	0 49 N A	4 38	☽
1749	Dec. 12 8 8	♋ 2 14	0 44 N D	4 36	☽
	Dec. 27 21 12	♑ 18 6	0 13 S D	7 9	☉
1750	June 8 9 9	♐ 28 16	0 15 S D	16 9	☽
	Dec. 1 18 32	♊ 21 13	0 3 N D	21 6	☽
1751	May 28 13 58	♐ 17 44	0 28 N A	10 8	☽
	Nov. 21 9 47	♊ 10 35	0 39 S A	8 18	☽
1753	Apr. 6 6 20	♎ 27 52	0 45 S D	5 14	☽
	Oct. 14 21 59	♏ 3 10	0 11 S A	8 3	☉
1755	Mar. 16 12 12	♈ 7 59	0 42 S A	7 13	☉
1757	Jan. 23 19 6	♌ 15 48	0 38 S D	6 43	☽
	July 19 11 53	♒ 7 51	0 30 N D	11 32	☽
1758	Jan. 12 18 13	♌ 4 20	0 ½ N A	21 27	☽
1759	Jan. 1 19 46	♋ 22 55	0 39 N A	6 41	☽
1760	May 18 9 35	♐ 8 51	0 52 N D	0 47	☽
	June 1 19 22	♊ 22 36	0 20 S D	4 35	☉
	Nov. 11 9 48	♊ 1 8	0 44 S D	6 30	☽

A Table

A Table of the Planets Diſtances, Eccentri-cites, Revolutions, &c.

	Mean Diſtance of the Sun	Eccentricity	Inclination of the Orbit (D. M.)	Periodical Revolution (D. H. M. S.)	Motion about the Axis (H. M. S.)	Sydereal Longitude (D. M. S.)	Aphel. Longitude Axis Node (S. D. M. S.)	Apparent Semidiameter (D. M. S. T.)	Heat
☿	38710	7970	6　54	87-23　15　53		7　13　48	0　15　42	5　00	6
♀	72333	517	3　24	224-16　49　24	23　00	8　5　00	1　15　16	10　30	2
⊙	100000	1732		365-6　8　30	23　56	8　8　20	1　16　30	10　30	1
♂	152369	14100	1　52	686-23　27　30	24　40	1　1　12	0　19　10	4　00	
♃	520110	25050	1　20	4332-12　20　31	9　56	5　9　50	2　8　00	24　00	
♄	953800	54709	2　30	10759-6　36　26		7　28　30	2　22　30	10　30	

Mean Diſtance of the Sun.

Eccentricity.

Inclination of the Orbit.

Periodical Revolution.

Motion about the Axis.

Sydereal Longitude.

Aphel. Longitude Axis Node.

Apparent Semidiameter.

Heat.

If one Direction, Station and Retrogradation of a
Planet be compared with another Direction, Station
and Retrogradation, they will be found unequal to
each other, not only with respect to the Arches in
the Ecliptic, but also with respect to their Time, and
this Inequality is greater in *Mars* than in *Jupiter* and
Saturn; then chusing a Mean betwixt the said Inequa-
lity.

	♄	♃	♂	♀ and ☿
The direct Pro-gressions of	244	284	705	542 93 *Days.*
Stationary	8	4	2	1½ ½ *Days.*
Retrogradations	136	119	75	42 22 *Days.*

♄ ♃ ♂ is Stati-onary when betwixt □ and △ Aspects with ☉
in △ Aspect with ☉
betwixt ⚹ and ♊ distant off ☉

SECTION VII.

Of Time and the Division thereof.

A Year is sometimes taken for the Time of the Re-
volution of a Planet through the Zodiac, in
which a Month is sometimes called a Year.

Another different Year is the entire Revolution (ap-
parently) of the fixed Stars, through the Zodiac,
which they call the *Annus Magnus*. But a Year is properly
that Time which the Sun takes to run through the Zo-
diac in, and is of two Sorts, the one Astronomical,
the other Civil: The Astronomical is twofold, accord-
ing to the two different Bounds of the Sun's Revolu-
tion; namely, *Sydereal* and *Tropical*: the *Sydereal* Year is the
Space of Time that the Sun having departed from a
fix'd

...'d Star returns to the fame in; and it is 365 Days, 6 Hours, and 9 Minutes nearly. The *Tropical* Year is that wherein the Sun departing from one of the Cardinal Points, the Equinoctial or Solstitial, returns to it again, and is fomewhat lefs than the *Sydereal*, becaufe the Cardinal Points of the Ecliptic themfelves go backwards, and as it were meeting the Sun. This *Tropical* Year is 365 Days, 5 Hours, 49 Minutes, 20 Seconds nearly, and wants about 20 Minutes of the Sydereal.

The Civil Year is the Space of Time that the Motion of the Sun or Moon, or both point at, received by the fettled Cuftom of any Nation or Country. There are three Forms of the Civil Year, *viz.* either purely *Lunar*, or purely *Solar*, or *Lunar-Solar*, which is made up of both. The *Lunar* Year confifts of twelve Lunations, or *Synodical* Months, that are finifhed in 354 Days, then begin again; this Year wanting near 11 Days of the *Tropical* Year, would wander through all the Seafons of the Year in about 33 Years: This Sort of Year is ufed among the *Turks*.

There are three Sorts of *Solar* Years, or fuch as are fitted to the Motion of the Sun alone, and the Vicifitudes of the Seafon depending thereon; the *Egyptian*, *Julian* and *Gregorian*; The *Egyptian* Year confifts of 365 Days, which they divide in 12 Months, of 30 Days each, and 5 Days to be added at the End; this Year wanting near 6 Hours of the *Solar-Tropical* Year, in 4 Years it gets near a whole Day before it. and in 1460 Years its Beginning wanders through all the Seafons of the Year.

Julius Cæfar finding this Year to want 6 Hours, he added the Day made of them in every 4 Years between the 23d and 24th of *February*. This *Julian* Year confifting of 365 Days, and every 4th Year of 366 Days, is beft fitted for *Aftronomical Computations*, becaufe it is a Mean between the Natural or Tropical Year of 365 Days, 5 Hours, and 40 Minutes; and the *Sydereal* Year of 365 Days, 6 Hours, and 9 Minutes. This Year was held common among all polite Nations, from *Auguftus* (who reftored

restored it when almost loft) unto the Year 1582, when the *Julian Kalendar* was reformed by GREGORY XIII; but it is still in use by us in *Britain* and *Ireland*, &c. Yet it must be confess'd, the Quantity of our *Julian* Year is too big. on which Account the Beginning of the Year creeps forward in Regard of the Seasons, or (which is all one, the Equinoxes and Solstices creep backwards, in regard of the Days of the Year. And since this Regress is about 10 Minutes, 20 Seconds every Year, in about 133 Years it will be a Day, and consequently from the Year of *Christ*, 325, wherein the Council of *Nice* was held, to the Year 1582, wherein the Pope reformed the Kalendar, namely, 1260 Years, this Regress was 10 Days. Hence it comes to pass, that whereas the Vernal Equinox happened about the 1 Day of *March* in the Time of the *Nicene* Council, in the Year 1582 it crept to the 11th, and this Year 1730. it is on the 9th Day, differing from the Ecclesiastical Vernal-Equinox (which is the 21st of *March*) 12 Days, which Variation is caused by our *Julian* Year exceeding our *Solar* Year by 11 Minutes, *near*.

SECTION VIII.

On EASTER.

OBserving of late, a vast Difference between our Ecclesiastical *Canons* thereupon, and the applying the celestial Full-Moons and Equinoxes. I shall take this Opportunity to impart my Thoughts thereupon, to satisfy the Curious therein.

The *Nicene* Council, *Anno* 325, decreed *Easter-Day* to be that *Sunday* which falls next after the first Full-Moon, that happens after the Vernal-Equinox, which we pretend to follow and explain in our *Rubrick*, where we design Easter-Day *to be always the first* Sunday *after the first* Full-Moon, *which happens next after the one and twentieth*

Day

Day of March; and if the *Full-Moon* happen upon Sunday, Easter-Day is the Sunday *after*, which laſt needs Amendment, for inſtead of the *Sunday after*, I ſuppoſe it ſhould be *that very Sunday*, according to both the Tables in the *Common Prayer*; and the reſt of it alſo needs further Illuſtration from the following *Remarks*.

1ſt, That the Eccleſiaſtical Vernal-Equinox is ſtill fix'd to the 21ſt of *March*, tho' the true, is now about the 9th or 10th, which Variation is cauſed by our *Julian* Year exceeding our *Solar* by 11 Minutes, near.

2d, That the *Paſchal* Full-Moon happens ſtill on the 14th from the *Paſchal* new, i. e. but 13 Days complete.

3d, That the Words *next after the* 21ſt, include that Day as certainly here, as in a few Lines after *Aſcenſion-Day is ſaid to be* 40 *Days after Eaſter*, includes *Eaſter-Day*.

4th. That the *Paſchal* Full-Moons which we obſerve are near 5 Days later than thoſe of the Heavens, becauſe they have loſt an Hour and Half every nineteen Years, ſince that general Council.

5th. The *Paſchal* New-Moon is bounded with *March* the 8th, and *April* the 5th, the *Paſchal* Full-Moon with *March* the 21ſt, and *April* the 18th; and *Eaſter-Day* with *March* 22d and *April* 25th, on which Limits, tho' they may happen, yet never can exceed them.

6th, 'Till the *Kalendar* be reformed, we are not to regard the Celeſtial *Equinoxes, Lunations*, or *Full Moons* as they happen in the Heavens now-a-days, But the reputed Eccleſiaſtical *Equinoxes, Lunations* and *Full Moons*, as they indeed happened in the Time of the *Nicene* Council, about 14 *Centuries* ago, which we obtain by the Direction of the old *Primes*, in the Eccleſiaſtical *Kalendar*, which here follow.

Prim.	Mar.
16	8
5	9
	10
13	11
2	12
	13
10	14
	15
18	16
7	17
	18
15	19
4	20
	21
12	22
1	23
	24
9	25
	26
17	27
6	28
	29
14	30
3	31

The Use, having the Prime and Dominical-Letter, to find EASTER.

IN the first Column quickly fee,
  Look out the *Prime*, where e'er it be,
The third *Sunday* after, *Easter-Day* shall be.
And if the *Prime* on *Sunday* be,
Reckon that for one of the Three.

Prim.	Mar.	D.L.	Prim.	April.	D.L.
16	8	D		1	G
5	9	E	11	2	A
	10	F		3	B
13	11	G	19	4	C
2	12	A	8	5	D
	13	B	16	6	E
10	14	C	5	7	F
	15	D		8	G
18	16	E	13	9	A
7	17	F	2	10	B
	18	G		11	C
15	19	A	10	12	D
4	20	B		13	E
	21	C	18	14	F
12	22	D	7	15	G
1	23	E		16	A
	24	F	15	17	B
9	25	G	4	18	C
	26	A		19	D
17	27	B	12	20	E
6	28	C	1	21	F
	29	D		22	G
14	30	E	9	23	A
	31	F		24	B
			17	25	C

Example 1*st*. Suppose the *Prime* 8, *Dominical-Letter* C. The Prime is against *April* the 5th, the first *Sunday* after is the 11th Day, the second *Sunday* is the 18th Day, the third *Sunday* is the 25th for *Easter-Day*.

Example 2*d*. Suppose the *Prime* 16, *Dominical-Letter* D.

The *Prime* stands against *March* the 8th on *Sunday*, the second *Sunday* is *March* 15th, the third *Sunday* is the 22d of *March* for *Easter-Day*.

But if any ignorant of the Ecclesiastical Full-Moons, shall apply in their Room the celestial Lunations and Equinoxes, they will find the Difference sometimes not only of Days, but Weeks: nay, a whole Month: As in 1720, 1723, 1747, 1750, 1774, 1777. (When *Easter* falls high, and the *Epact* very little, or very large) and if no Reformation be, the Error will be 6 Weeks. *Anno* 2437, and after 2698 *Easter* will never happen according to the Decree of the *Nicene* Council.

N

To

To conclude, I shall humbly propose to the Confideration of my learned and judicious Superiors, a brief easy Way to reconcile the Kalendar to the Heavenly Motions, as they were at the Beginning of our Christian Æra, without Confusion in the Dates of our Civil Contracts, *&c.*

For the Term of fifty-two Years to come, omit all the *Biffextiles*, which will be thirteen Days: This alone would gradually and infensibly, without the least Inconvenience, bring us two Days before the *Gregorian* Account, and be agreeable to the Sun's Motion at our Saviour's Birth, and cause the Festivals to be kept according to primitive Obfervation, after which fifty-two Years, obferve the Leap-Years as ufual, till even Centuries as 1800 and 1900, count common Years; but 2000 make a Leap-Year, and every fourth Century enfuing, which will prevent the Variation of one whole Day in 10000 Years.

SECTION IX.

Of the Æquation of Time; and to regulate Clocks and Watches.

HOW beneficial and neceffary Pendulum-Clocks and Watches are in the Affairs of Human Life, 'tis needlefs to relate: But fomething refpecting their right Ufe and Mathematical Underftanding of them, may be acceptable to feveral.

The Clocks I here mean, are fuch as are made by a skilful Workman for a Piece ill made may vary from the equal Time a Quarter of an Hour in a Month. Whereas a Piece made by a judicious Hand will not err a Minute in the fame Time, if truly adjufted. As to the Exactnefs of thefe long and weighty Pendulums,

dulums, we are by many curious Experiments fufficiently fatisfied, that they are the moft fteady of all Artificial Motions, yet it will not point out by the Index continually the fame Time given by the Sun on an exact Dyal : but in a few Days we may be fenfible of the Gain or Lofs betwixt the Dyal and Pendulum-Clock; now this Difagreement is not occafioned by any Defect of the Clock, but proceeds from a two-fold Inequality in the Heavenly Motions; to wit, the Eccentricity of the Orbit of the Earth, and the oblique Pofition of the Equator to the Ecliptic.

As to the firft; we may obferve, that if the yearly Orbit were indeed circular, and had the Sun in the Center; fo that the Diftance of the Sun from the Earth fhould be always the fame, no Caufe of this Inequality would be found in the Figure of the Earth's Orbit: But in the Elliptical Orbit, where the Quantity of the diurnal Motion is unequal, and diverfe in fome Days from what it is in others, the Thing muft be neceffarily otherwife; unequal Portions being continually added to the diurnal Revolution. As for Inftance; in the *Aphelia* the Earth by its flower Motion doth daily change its Angular Pofition to the Sun, lefs than it doth in the *Perihelia*, and confequently the Angle is lefs. which it doth then finifh over and above its entire Revolution, to be added to that Revolution, that fo the Solar Day may be completed; for the diurnal Motion, which as to the fuperior Focus of the Ellipfis, is always nearly equal, is confiderably unequal, with refpect to the Sun near the inferior Focus; and thus an Inequality muft needs be introduced into the Natural Days.

The other Caufe of the before-mentioned Inequality. is the oblique Pofition of the Equator to the Ecliptic. If the Axis of the Earth were always moved parallel to the Axis of the Ecliptic, and confequently the Plane of the Equator had coincided with that of the Ecliptic. there would be nothing in the Earth's Pofition. with refpect to the Ecliptic, that might caufe this Inequality, But when the Diurnal

urnal

urnal and Annual Motions are performed on very different Axes, then an Inequality of Days muſt neceſſarily take Place. For in this, the Sun's Longitude along the Ecliptic, and the diurnal Motion along the Equator, which we call the Sun's Right Aſcenſion, are both taken into the Account; and unleſs every Arch of the Ecliptic anſwered to every equal Arch of the Equator, ſo that there were no Difference betwixt the Longitude of the Sun and his Right Aſcenſion, which Thing cannot be; there muſt moſt certainly an Inequality of Days ariſe from thence, *E. G.* Let the Longitude of the Sun be five Degrees, his Right Aſcenſion then muſt not by Trigonometry, exceed four Degrees, thirty five Minutes. and a Quarter, which wants twenty four Minutes and three Quarters to be equal with the Sun's Longitude: This Defect of twenty four Minutes, forty five Seconds turned into Time, comes to one Minute, forty Seconds *fere*, which Space, tho' in it ſelf may ſeem ſmall, yet when it is augmented for many Days ſucceſſively. by an almoſt equal Increaſe, will introduce in a while an Inequality too great to be neglected.

Both the Quantity and Place of theſe two Cauſes of the Inequality here mentioned are very different in this our Age, and require to be diſtinctly calculated. Now the former of theſe Cauſes, to wit, the Eccentricity of the Orbit, which differs wholly from the latter, remits us to the *Aphelia* and *Peribelia* for an Equation of Time, which anſwers to the Quantity of that Eccentricity. and is once a Year to be added to the apparent Time, and once to be ſubtracted from it. But the latter of theſe Cauſes which is plainly different from the former, makes an Equation of Time equal to the Difference betwixt the Sun's Longitude in the Ecliptic. and his Right Aſcenſion in the Equator; and which being to be reckoned from the Equinoxes to the Solſtices, and from the Solſtices to the Equinoxes, is twice a Year Additititious, and twice Ablatitious, and is almoſt one and an Half of the Eccentric Equation,

The

The whole Equation therefore of Solar Days is not to be gained from either of thefe Caufes fingle or alone, but from the Combination of both, for where both the Equations are Addititious, or both Ablatitious the abfolute Equation of Time arifeth from the Sum of them, which is to be added to, or taken from the true Time, according to the Tenor and Name of both the Equations; and where one is addititious (or to be added) and the other ablatitious (or to be taken from) thence for obtaining the Mean or even Time, the Difference of them is to be added to, or taken away from the true Time, according to the different Time of the Year, and Title of the Greater.

From this we may plainly obferve, that there is a Neceffity of this Equation of natural Days, feeing it is founded on true Aftronomical Principles, and proved by correct Obfervations. I fhall in the next Place apply it to Practice in regulating curious Clocks. Firft, we muft obferve that a Pendulum-Clock goes equal, that is, one twenty four Hours at any Time of the Year, is as long as another twenty four Hours at any other Time of the Year; and this is perpetual and conftant, and therefore ought to differ from the apparent Time fhewn by a Sun-Dyal, or other Inftrument, as much as is the Equation of Time in Excefs or Defect. Thus, you may fee by the Table, that there are only four Days in the Year on which the Equation of Days ceafes, that is, the apparent and mean Time are then the fame. *viz. April* 4th, *June* the 6th, *Auguft* the 21ft, and *December* the 13th. If on any of thefe we fet a well regulated Pendulum-Clock to the apparent Time fhewn by the Sun on any Day afterwards, it ought to differ from the Sun fo much as is the Equation of Time by the Table, if the Equation is to be fubtracted, the Pendulum ought to be fo much flower than the Sun, and if the Equation is to be added, the Pendulum ought to be fo much fafter than the Sun.

M 3   Thus

Thus, if at any Time you defire to adjuft your Clock, and bring it to meafure the equal Day, you muft either add or fubtract the Equation of that Day to the apparent Time given by the Sun, and fet the Clock to it, For Example, the Year 1720, *Jan. 1ft,* at Noon (*the apparent Time, or true Noon being found by a Dyal, or true Meridian Line*) in the Table of Equation, I find eight Minutes, forty feven Seconds, with Title add, wherefore I fet my Clock eight Min. forty feven Seconds paft Twelve; and obferve the third, Day if it be nine Minutes, thirty two Seconds fafter, then the Clock goes well; but if it goes too faft, fcrew down the Bob, till it gain, as in the Table (at that Time of the Year) and if to go too flow fcrew up the Bob, till it agree in going with the Table. Therefore your Clock muft always go fo much fafter or flower. as the Equation in the Table, agreeing with the Time of the Year.

Thofe Pendulum Clocks by Experience is found, Whofe Swing in a Minute makes fixty Rebounds, (As by Tryal you'll find) if you meafure their Lengths, Will contain juft thirty nine Inches two Tenths; If fo, then how long muft that Pendulum be That fhall make the fame Number of Swings to agree With the Number of Inches its Length doth contain In the Space of a Minute, I'd know very fain?

Anfwer. According to *Ricciolus,* Reciprocal Pendulums are to each others Length, as the Squares of their Vibrations in the fame Time. Therefore Inches 51.0630399162510827I, which is the Cube Root of the Product of 39.2 multiplied by the Square of 60. is the true Length of a Pendulum, the Number of whofe Vibrations (in one Minute of Time) and Inches fhall be equal to each other.

Divide

Divide 141120 the Product aforesaid, by any given Length, the Quotient is the Square of the Number of Vibrations fought. *Or*,

Divide 141120 aforesaid, by the Square of the Number of Vibrations given, the Quotient will be the Length of the Pendulum fought, thereunto belonging for one Minute.

Moreover the Length of a Pendulum vibrating Seconds at *Paris* is three Feet eight Lines and an half; let it be required to find the Length of a Pendulum vibrating Seconds at the Equator.

Because the Gravity at the Poles is to the Gravity at the Equator as 692 to 689, therefore the Decrease of Gravity at the Equator is $\frac{3}{692}$ Parts of the whole Gravity; but the Decrease of Gravity at the Equator is to its Increase in any other Latitude, as the Square of Radius is to the Square of the Sine of the Latitude: as 1000000 the Square of Radius to 565248, the Square of the Sine of the Latitude 48 Degrees, 45 Minutes Latitude of *Paris*, fo is 3 the Number which reprefents the Decreafe of Gravity at the Equator to 1.695, the Number which reprefents its Increafe at *Paris*, which added to 689, the Gravity at the Equator makes 690.695, the Gravity at *Paris*.

Then as 690.695 Gravity at *Paris*.
      To 689 Gravity at the Equator.
   So is 36.708 Length of a Pendulum at *Paris*.
      To 36.616 Length of a Pendulum at the Equator.

The Difference $\frac{92}{1000}$ Parts of an Inch agreeing pretty near to the Obfervation of Monfieur *Richer*, who at the Ifland of *Caen*, whofe Latitude is five Degrees, found that a Pendulum there, was $\frac{1}{10}$ of an Inch fhorter than at *Paris*.

S E C
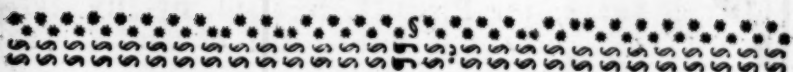
SECTION X.

To discover a Ship's Distance at Sea, and to know when you have cross'd the Line or the Poles, were it possible.

IN sailing near Land, if you spy two Lands, whose Distance you know, and they bear off you one Point distant asunder, when you were athwart them you are five Times their Distance from Shore, if they bear two Points, then are you 2 times and an $\frac{1}{2}$ their Distance, if 3 Points, then 1 and $\frac{1}{2}$, if 4 Points, then the same Distance, if 5 Points, but $\frac{2}{3}$ of that Distance, if 6 Points, then but $\frac{1}{2}$ their Distance.

To know when you have cross'd the Equator.

Observe if you can see *Charles's Wain* and the Guards, or Circumpolar Stars, then is the *North* Pole elevated; or if you look towards the Equator, you shall see the Stars ascend from the Left towards the Right, if in *North* Latitude; but from the Right towards the Left, if you be in *South* Latitude.

To know whether you are going to, or from the Poles.

Seeing from the *North* Pole all Places bear *South*, and near the Pole the Compass is of little Use; then get a good Clock, mark'd with 24 Hours, and an Index which shall every Noon return to 24, then when under the Pole, look and see if the Index point at 24, then that Point where the Sun is, is directly back again from the Pole.

If

If 12, then towards the Sun is right forwards.

If 6, then towards the Sun is Earth due *West*.

If 18. then towards the Sun is Earth due *East.*

Wherefore to go directly homeward, because I came out *North* and must return *South.* I lay the Fly of the Compass steady before me, and the *South* Point right with the Ship's Head or Stem, then if the Clock point 24 Hours, then I steer the Ship directly upon the Sun.

| But if the Clock point | 3 6 9 12 15 18 21 | Then he that doth steer, must keep the Sun. | South West. West. North West. North. North-East. East. South-East. |

But if you would go directly forward, then lay the *North* Point right with the Ship's Head, and when the Clock doth point 12, steer right upon the Sun.

As an E P I L O G U E *to this* Mathematical Miscellany, *I shall subjoyn some few Paradoxical Questions, which whoever shall send the true Solution of before* 1737, *to the Bookseller at the* Globe *in* Meath-Street, *he shall have his Chance by Lot, to win a Dozen of these Tracts, next* New-Year's-Day, *to oblige his Friends with.*

NUMBER I.

I. OU R Porridge-Pot, is sick, (I wot)
    But what's the Matter with it.
I cannot tell, nor yet reveal,
    If that the Deel's not in it.

H. With

II. With Noises great it doth affright,
   When first its fill'd with Water,
And hung o'er Fire, with black Attire,
   But what can be the Matter?

III. The Reason then I wou'd know, when
   Your Leisure doth permit.
Is't not a Frolick. or else the Cholick?
   And what a sad Thing is it?

IV. Pray then be sure to send the Cure;
   For if it shou'd be catching,
And other Pots do take their Lots,
   What Mischief will they hatch then?

V. One Humour good, I tell you shou'd,
   Our Porridge-Pot has gotten.
When boiling Diet, it is quiet,
   And Pudding therein sodden.

NUMBER II.

ASpire my Genius! Help my rhyming Muse,
   In Themes I in my native Country chule:
Whilst others plow the Waves and tread the Strands
Of distant Oceans, and of foreign Lands;
To fill the Mouth of Fame with somewhat new,
(No matter 'tis how much of it be true)
From Alps or Mountains, Stories strange they bring;
Of desart Caves. or horrid Monsters sing.
Tell how *Vesuvius*' sulph'rous Darts do fly,
Or *Ætna*'s Smoke obscure the Azure Sky;
Or magnify the Hazards they have run.
Scylla's and *Charybdi*'s pointed Rocks to shun.
   Such Tales we take on Trust, from those who rove;
Tho' none give Rules by which the Truth to prove.
   But this by Numbers may explained be,
By those who never did the Cavern see:
In *Derbyshire*, a Wonder of the *Peak*,
Is *Eldon Hole*, as Poets often speak;

                         Whose

Whofe Depth exactly, none could e'er defcry,
Tho' Atheift *Hobbs* his utmoft Skill did try,
Who wrote *De Mirabilibus Pecci.*

   And Burlefque *Cotton* does ftrange Tales rehearfe,
In R..ftic Words, and *Hudibraftic* Verfe,
How he this monftrous Orifice did plumb,
But could not at the Bottom of it come,
With fixteen hundred Yards of Rope let loofe;
And tells a Story of a Woman's *Goofe* :
Fabulous the one, fo may the other be,
Erroneous too, without Philofophy;
Extenfion of the Rope might him deceive,
And fmall Proportion which the Plumb would have
To fuch a Length; and Part in Water drown'd,
When in this vaft Abyfs, within the Ground.
   But I the Depth have found exactly true,
By *Gravity.* a Method fomething new.
As heavy Bodies do accelerate,
In Spaces known firft to our *NEWTON* Great.
Four pond'rous Stones into the Well let fall,
In meafur'd Time, agreed in Numbers all;
A Pendulum fixty one Inches long,
By which the Time I meafur'd (was not wrong)
Vibrated freely, whilft that each Stone fell,
Eight Times; by which the Depth I'd have you tell:
Allowing rightly for th' Approach of Sound,
That your own Works may not themfelves confound.

NUMBER III

SInce the Idea of Sound is conveyed to us by a Vibration communicated from the Air to the *Membrana Tympani*; I defire to know how a Man, when twenty Inftruments are play'd upon at once. notwithftanding the Multiplicity of Vibrations, fhall be able to diftinguifh, plainly, one falfe Note from all the reft.

NUMBER IV.

ÆLIA, Lelia, Crispis,
Nec Vir, nec Mulier, nec Androgyna,
Nec Puella, nec Juvenis, nec Anus,
Nec Meretrix, nec Pudica,
Sed omnia:
Sublata neque Fame, nec Ferro, neque Veneno;
Sed omnibus:
Nec Cælo, nec Aquis, nec Terris;
Sed ubique jacet.
Lucius Agatho Priscus,
Nec Maritus, nec Amator, nec Necessarius,
Neque Mœrens, neque Gaudens, neque Flens,
Hanc neque Molem, nec Pyramidem, nec Sepulchrum,
Sed omnia,
Scit & nescit quid posuerit:
Hoc est Sepulchrum, intùs Cadaver non habens;
Hoc est Cadaver, Sepulchrum extrà non habens,
Sed Cadaver idem est, & Sepulchrum sibi.

This is a famous Inscription in Senator Volta's *Country-House, near* Boulogne *in* Italy.

FINIS.

um,

pufe,